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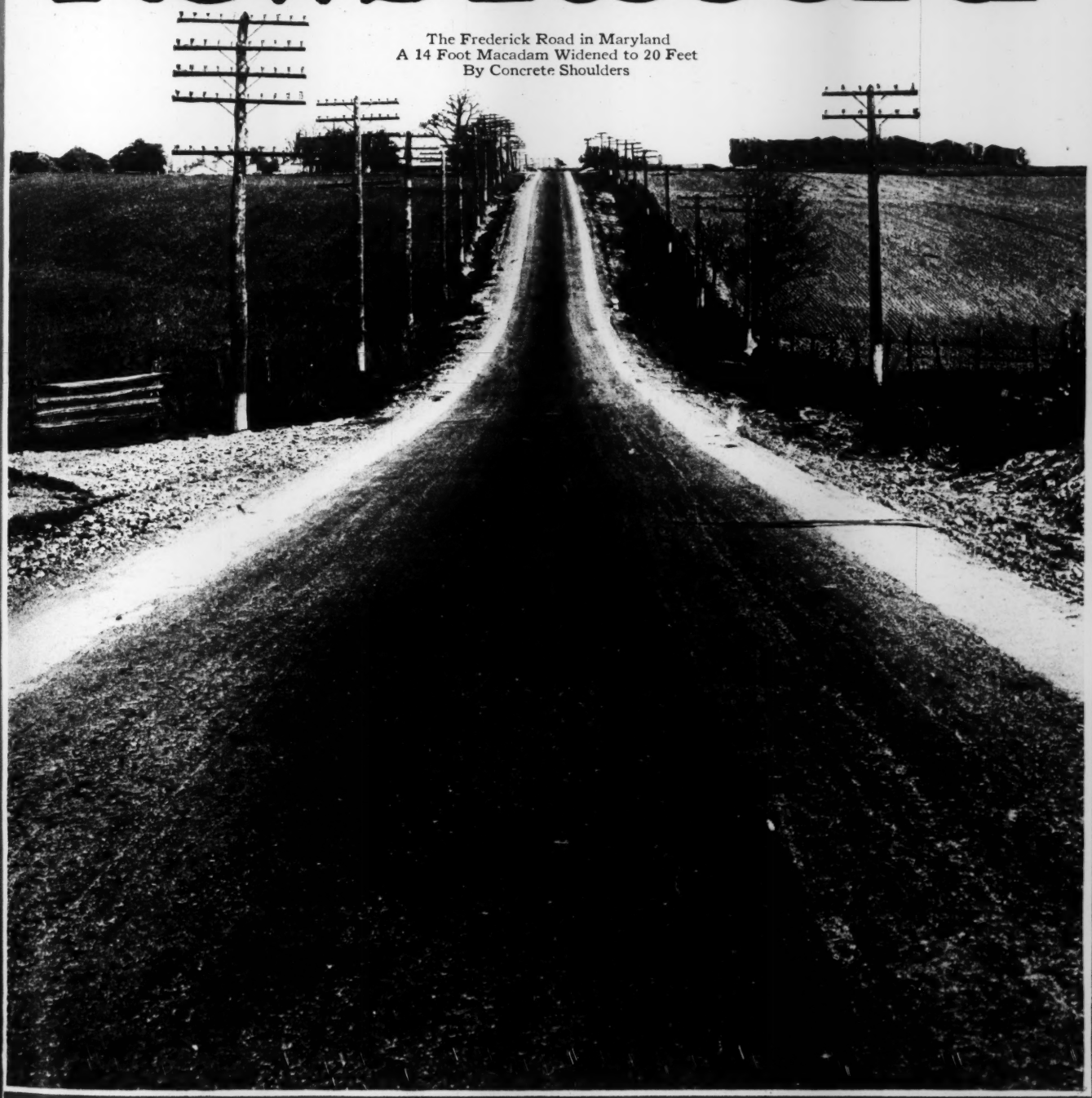
Engineering News-Record

The Frederick Road in Maryland
A 14 Foot Macadam Widened to 20 Feet
By Concrete Shoulders



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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN *Editor*

Volume 89 — NEW YORK, JULY 13, 1922 — Number 2

Mr. Chandler's Retirement

THIS week Mr. Chandler relinquishes the acting secretaryship of the American Society of Civil Engineers. His going should not be without a word of commendation for his regime as the society's executive officer. He came to New York as the avowed selection of the progressive group of the Board of Direction. Quite naturally, therefore, the conservatives were on the alert to detect partisanship in his conduct of society affairs. But there was no partisanship. Mr. Chandler acted as he should have acted—not as the executive of the progressive group but of the whole society. He was tactful, he was human, and he won the admiration of those who looked upon him at first with suspicion. It appeared for a time that he might be the means of finally healing the breach between the two elements in the society's leadership. But that was not to be—due to his loss of the support of most of those who put him into office. For his diplomacy Mr. Chandler has been much praised. But he had more than diplomacy. He had backbone and conviction and to his backbone and conviction is due, at least in part, his elimination from the secretaryship. Just what were the motives of the board in replacing him has not been declared. It is to be hoped that they were due to honest disagreement on society policy between him and his opponents. Moreover it should be remembered that the new secretary was elected over Mr. Chandler only after repeated ballots and by a narrow margin. Brief though his regime, then, Mr. Chandler has reason to be gratified at the prejudice he overcame in New York and to be proud of the fact that his return to the West is due, primarily at least, to his faithfulness to his own views, even to breaking with those who were responsible for his election.

Traffic, Not Safety

PEOPLE have had the Brooklyn Bridge falling down for years. As far back as 1881, two years before it was opened to traffic, there was an editorial in this journal ridiculing an attack on the safety of the bridge. It is a favorite last resort of the Sunday supplement editor to picture the terror of the snapping cables and twisted trusses with miniature trains and pigmy bodies hurtling through space to the river. The alarmists have now another chance, for the city has barred the bridge to motor traffic. Hereafter only horse-drawn vehicles can use the roadway, and the newspapers are asking experts about overloads and crystallization and other high sounding things that may presage early dissolution of the bridge. This is unnecessary agitation. The Brooklyn Bridge is overloaded and has been overloaded for many years but the few motors that are not to be allowed on it now will not reduce that overload very much. The new order is a traffic corrective and is merely an indication of what the growing traffic problem is to do to our accepted ideas of rights of travel. The Brooklyn Bridge roadways are narrow and the approaches to them tortuous. A few weeks ago a new roadway was opened on the nearby Manhattan bridge which could be readily reached and quickly traversed and the opportunity was taken to reroute and classify the traffic—at the same time, but only incidentally, reducing the wear on the Brooklyn Bridge roadway and relieving somewhat its floorbeam loading. The Brooklyn Bridge's future is a serious problem but this particular move is not an indication of any immediate danger; the safety factor under the new order is but little different than under the old.

Discretion, the Need of Emergency

TWICE during the last week the New York subway has been the scene of accidents that have tied up the movement of trains for long periods. On both occasions passengers have been confined to the cars, some of the time in darkness, both literal and figurative. That panics did not occur is due no doubt to the patience and good judgment of the traveling public and to the extraordinary record of safety that has been achieved by the subway during its eighteen years of operation. Yet we cannot forbear to ask ourselves two questions in this connection. Why is it usually so difficult to obtain information as to the cause of delay in almost every department of transportation service? Much of the danger of panic under such conditions can be averted if those affected are generally informed as to the cause of the delay or difficulty. And why is it necessary to hold passengers cooped up in subway cars long after some one in authority must know that a delay is to be of long duration? Despite the conditions under which a rapid transit subway in New York City must be operated, means could be devised for investing someone on the ground with authority to discharge trains stalled between stations for long periods. Rules and regulations are essential in the public interest, but a blind and rigid adherence to rules and regulations in the face of emergency conditions will often prejudice the very public safety they have been designed to insure. If we must deprive the rank and file of every vestige of discretion, we must provide over them an authority that will be sufficiently decentralized and flexible to cope with emergencies.

The Price of Stability in Construction

A SEWER-CONSTRUCTION job was recently put under contract in Jersey City, N. J., at a price little more than 30 per cent of the low bid for the same work received Aug. 10, 1920, and 59 per cent of the low bid taken Oct. 19, the same year. Contrasting these prices with the actual variation in materials and labor prices the 1920 bids contained heavy insurance against any labor or material-price fluctuation, far out of proportion to any sum warranted by actual current prices. Applying *Engineering News-Record's* construction cost index

number, the August, 1920, bid was more than double the actual cost of doing the work, assuming that costs upon which bids were taken could have endured while the work was in progress. In other words the unsettled conditions at the price peak forced the contractor to add to his bid a contingency that represented half the cost of doing the work today. Though the Jersey City job may represent extreme conditions, it is indicative of the tremendous loss in construction work which must be charged to a psychologioal condition. What can be done? Labor is hard to control. If contracts exist they are not considered inviolable, particularly in troublous times. And price quotations are as changeful as the winds. However, the direct money loss involved forces an acknowledgment that the job is worth tackling.

Contractor's Concrete Specifications

THE resolution of the Associated General Contractors, noted in the news columns, authorizing its committee to "prepare specifications for concrete and reinforced concrete which in their opinion would be reasonable," probably does not indicate so serious a division of opinion between the engineers and the contractors as its first reading would suggest. The Joint Committee is endeavoring to produce a satisfactory concrete specification. Its tentative effort, now out a year, has met with much criticism, which was to be expected, but the committee is now in possession of all of this criticism and is prepared to proceed to a final revision which should be materially changed from the first draft and should, further, come near to expressing the latest expert ideas on the design and production of concrete. It is reassuring to learn that the contractors, through their associated body, are not undertaking to produce a rival specification, but are merely to prepare a specification probably not for publication but as a positive statement of their views which have hitherto been expressed as negative criticism of the Joint Committee report. At all the public discussions of that report the critics, who have frequently voiced the contractors' opinion, have been asked for definite substitutions satisfactory to them. Probably this proposed work of the A. G. C. committee will do just that thing.

Federal Aid Stabilized

WHEN the President last month signed the Post Office appropriation bill authorizing $190,000,000 of government funds for road construction during the next three years—in addition to $13,000,000 for forest roads in 1923 and 1924—assurance of stability was given to the policy of federal aid. Fifty million dollars were made available for the year which began July 1 and $65,000,000 and $75,000,000, respectively, were authorized for the two succeeding fiscal years. It is true that these appropriations fall short of the amount considered necessary by state highway officials if state road systems are to be completed within a reasonable time to meet the demands of traffic. Estimates have commonly been based upon an assumption of $100,000,000 yearly of federal aid. While the states, therefore, do not get all they sought, they can now plan their work in the full knowledge that a continuing policy of governmental assistance is established, in spite of the fact that the new legislation reduces the maximum participation by the government from $20,000 to $16,250 per mile for roads for the current year and to $15,000 per mile thereafter. An important part of the new act is its provision for extending federal aid to structures involved in the elimination of railroad grade crossings. Otherwise the work will be administered as it has been since the establishment, last year, of the 7-per cent system of primary and secondary routes. The U. S. Bureau of Public Roads reports that plans for the interstate and intercountry systems have been received from all but eight states and that the state systems are being co-ordinated to serve the best interests of the country at large. The new appropriations come opportunely, for several states had almost reached the limit of funds available. It is estimated that the $190,000,000 lately authorized will result in the construction of more than 25,000 miles of road which, added to the 46,000 miles estimated to result from previous appropriations totaling $350,000,000, will produce a total of 71,000 or nearly 40 per cent of the 180,000 miles of road in the 7-per cent system of federal-aid routes now outlined. Uncertainty as to the future of federal aid is removed and the states can now lay their plans for at least three years to come.

Another Simplification Proposed

SIMPLIFICATION of styles and sizes is the first step toward the elimination of waste, according to the studies of the committee of the Federated American Engineering Societies appointed to investigate that subject. Unfortunately the greatest economic losses from too many and varied styles lie outside the jurisditcion of engineers in the uncharted and uncontrolled realm of fashion. In those fields where engineers have some influence, however, progress toward simplification is being made. Already the paving brick industry has cut down its standard shapes and sizes from sixty-six to seven and the reinforcing bars rolled to standard have been reduced to ten sizes. Now the lumber people are going to get together with the Forest Service and the Department of Commerce in an effort to standardize lumber grades and sizes which will mean a reduction in the multitude of sizes and grades now prevalent. Lumber is a fertile field for such simplification, not only from the standpoint of the producer, who should save money by direct reduction of costs, but also from that of the consumer, who will be saved time and bother in size and grade selection.

County and State Highway Liaison

IN EVERY state highway department there should be a liaison bureau whose specific purpose it is to carry the doctrine of sound highway management into the counties and co-ordinate the highway thinking of county and state. As a general rule county road management is less advanced than state management. In this conclusion the committee of the Nebraska State legislature, whose findings are published in another column, is in agreement with all previous investigations and with general observation. The Nebraska study, in common with previous ones, announces only the obvious reasons that county highway accounting is insufficient and county highway engineering is inefficient. To leave the question at this point does not get us far. Poor accounting and mediocre engineering are effects instead of causes.

The Nebraska report indicates that there are counties in which highway management is as capable and as keen for efficiency as in any state highway de-

partment. This conclusion also tallies with general observation. The accounting and the engineering in these counties is obviously competent but the fundamental condition is that the people have been educated to require good highway management. In general it can be asserted that wherever a favorable comparison can be made between county and state practice the possibility is due to an usually highly educated public sentiment which demands and supports sufficient and competent county engineering.

The wisdom of these exceptional counties should be carried into all counties and this is a task which state highway departments might well assume. Practically all state highway departments recognize this duty, at least as a theory, but it is performed only incidentally and by indirect influence. In only one or two states is it recognized as a task to be performed by a bureau organized for the specific purpose. This liaison work is not of a kind that can be well done as an incidental task. Local jealousies have to be overcome and the technicalities and economics of proficient highway management have to be taught. These are tasks which require the entire effort of competent heads of a department bureau organized and financed to do the work.

An Engineering Anniversary

ENGINEERING suffers from a lack of interest in its own traditions. We are proud to have it esteemed a forward-looking profession. Our boast is that we are so occupied with the problems of today and tomorrow that we have scant opportunity to contemplate our achievements of yesterday. Sound and creditable as this attitude may be, it is possible to lean over backward, and in our devotion to what we hold modern, practical and progressive, to deny ourselves the inspiration to be derived from reflection upon the worth of those who have preceded us. Such inspiration is real and practical, for it is the prop that has sustained every craftsman and every professional man since mankind first began to take pride in its work.

With this thought our mind turns back to 105 years ago when the first contract was signed for the construction of the Erie Canal across New York State. On Independence Day of that year, 1817, the first earth was turned in the enterprise just west of Rome, N. Y.

It is scarcely possible to exaggerate the importance of this anniversary to American engineers, for out of the labor of that undertaking was born the American profession of civil engineering. It is true that earlier surveys had been made for public works in many parts of the land and that some of them were built. But almost without exception the conduct of those works was in the hands of European engineers. The American engineer had not yet arrived. Indeed, it was largely by chance that the Erie was begun under American auspices, for the state tried hard to secure the services of William Weston, an English canal builder who already had designed and built several works in this country. He, however, finally refused on the grounds of advanced age and ill health.

So it came to pass that Benjamin Wright and James Geddes, surveyors who had been engaged on some of the preliminary surveys for the canal, came before the board, expressed their confidence in their ability to locate and build the canal, and bespoke on the part of the commissioners an equal confidence. It was granted. As might have been expected, sapient legislators and political opponents of the canal at once rose in their places demanding with fine scorn, "Who is Geddes and who is Wright? And what canals have they ever built?" Then, too, hostility took another tack. Some, for example, insisted that the engineer's spirit level never would suffice to run the long canal levels, which when built, would probably be off by the total depth. So Wright went out and ran two independent lines each more than 60 miles long, checking on the closing within 1½ in. And that settled that.

Today we marvel at the courage and the resource of those professional pioneers who were to link the waters of the Atlantic and the Great Lakes through more than 350 miles of what was almost trackless forest. Of experience they had had practically none. Systematically organized engineering science was as yet unknown. Few books were available. Every problem that arose must be solved from its very foundation principles through to its final application. Not only were they to overcome the physical obstacles that beset them, but they were also to devise means of administering public works until then unnecessary and unknown. Out of the Erie Canal the American contractor came into being, for it was decided that the work should be divided into short sections and let to individuals who would undertake their construction. During the course of this work much interesting information and many valuable data were gathered and incorporated into our fund of engineering knowledge. There was developed the use of plows and scrapers for excavation, the consolidation of embankments by teaming over them, ingenious plant for clearing and grubbing, and, most interesting of all perhaps to contractors, the institution of payment on monthly estimates.

Out of that splendid corps came a coterie of tested men who were destined to write their names high in the annals of the profession, which through this undertaking they were founding in the new nation. Aside from the two leaders, there were Canvass White, who first produced American hydraulic cement, and who designed the mechanical structures of the canal; Holmes Hutchinson, who was later called upon to design and build canals and railroads in several states; Nathan S. Roberts, who designed and built the Lockport flight of locks, and later was builder of canals in Pennsylvania, of the Harpers Ferry bridge, and engineer for the federal government on a proposed ship canal around Muscle Shoals, and John B. Jervis, builder of railroads and water-works and eventually president of the Chicago & Rock Island R.R. These are but a few.

In 1825 the canal was completed. It was 363 miles long, 40 ft. wide at the water surface, and 28 ft. wide at the bottom. Its depth was 4 ft. Eighty-three locks, each 90 x 15 ft., overcame a total rise and fall of 675 ft. and eighteen aqueducts, mostly of cut stone, carried the canal over streams and other obstructions. The time between Buffalo and Albany had been halved. The cost was $7,000,000.

Small wonder, then, that Benjamin Wright has been called the "Father of American engineering." Small wonder, too, that the historian of the opening ceremonies was able to inscribe his triumphant enthusiasm in these words: "Europe begins already to admire—America can never forget to acknowledge that they have built the longest canal in the world, in the least time, with the least experience, for the least money, and to the greatest public benefit."

Hydro-Electric Development Involves Unusual Tunnel Job

Reconstruction of Kern River Plant Requires Enlargement of 8,300 Ft. of Rock Tunnel—Location, Topography, and Ground Give Rise to Special Problems

By H. K. Fox
Superintendent, San Joaquin Light & Power Corporation, Fresno, Cal.

ENLARGEMENT of a grade tunnel through blocky and otherwise difficult ground to a pressure tunnel having a cross-section more than four times as large was the outstanding element in the reconstruction of the Kern River plant completed last summer. The special problems to be solved made necessary the application of special equipment and methods and ment of the Kern Canyon project called for the total installation of 18,000 hp., so authority was given to construct an entirely new plant of 12,000 hp. capacity and to provide tunnel capacity for the ultimate development and foundations for the future unit of 6,000 hp. Fig. 1 shows the general layout of the job of which a better conception will be obtained if it is borne in mind

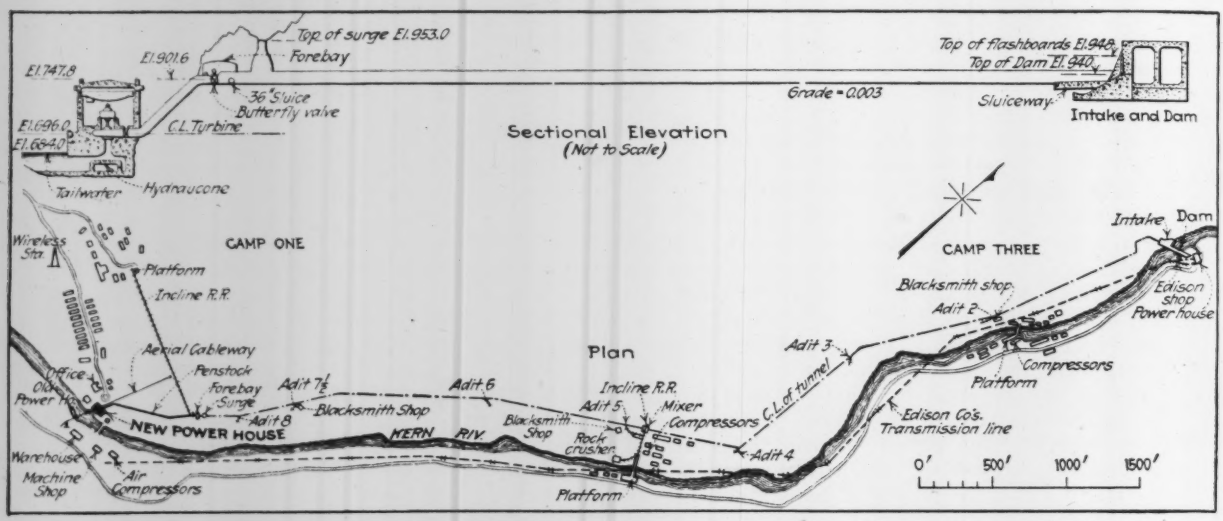


FIG. 1. GENERAL LAYOUT OF KERN RIVER DEVELOPMENT

Here are shown the general scheme of the installation and the location of the three construction camps. Camp One was job headquarters. All the adits were used for access to the work thereby making possible simultaneous progress at many points as well as excellent ventilation and little loss of time waiting for the tunnel to clear after blasts. All the concrete was mixed at Adit Five, which was centrally located. Materials were brought in by the road on the east side of the canyon and then handled to the mixer as is illustrated in Fig. 5 herewith.

illustrate aptly the engineering function of adapting available means to a desired end in the interest of speed and economy. The location and surroundings raised also problems of subsistence for the working forces that are not frequently met with in engineering construction work. The new plant as installed develops two-thirds of the economic capacity of the site and has been arranged for convenience of future enlargement to full capacity.

The original development of the Kern Canyon project of the San Joaquin Light & Power Corporation, located on the Kern River approximately eighteen miles northeast of Bakersfield, Cal., was completed in 1890, and consisted of a flume, a very crude diversion, steel pressure pipe, and two wheels, with generators of 400 kw. each. Later, because of mountain slides destroying the flume during the rainy season, a tunnel 6 ft. 6 in. x 6 ft. 6 in. was driven and the intake moved upstream to the tailrace of the development above. On account of the inefficiency of the two old units, another unit of 3,000 kw. was installed in 1917.

In the fall of 1920 a study of the stream flow of the Kern River made it evident that the economical development that the river flows through a deep narrow canyon ending abruptly at the power house site. This is strikingly shown in Figs. 2 and 3.

Condition of Old Tunnel and Penstock—The old plant was shut down Jan. 28, 1921, whereupon an inspection offered an opportunity to study the wear after thirty-one years' operation. The tunnel had been driven very close to the surface, and had eight adits in its length of 8,300 ft. The ground being mostly a very poor grade of granite and very blocky, at places nothing but slides of rock and earth were encountered. The sides and floor were lined with concrete and the roof arched where the ground required it. Only one cave-in was found, it being the only wet place in the roof. The walls had been laid up dry and faced with hand-placed plaster and the floor had been poured two inches deep on top of the ties and muck. The latter was about fifty per cent washed out but the walls as a whole were in excellent condition. Some slabs from the floor were turned up on edge and obstructed the flow materially. The redwood timbering was concreted in, and being within two inches of the surface of the concrete, had caused failure in one place. There was no serious

amount of moss clinging to the concrete. Through one adit it was possible to crawl into an underground chamber over the tunnel, about 200 ft. long and 5 ft. high, formed by the arching of the loose rock and earth over the concrete roof of the tunnel. This chamber had been formed during the excavation of the tunnel by the fine dirt sifting down through the lagging.

Intake and Diversion Dam—Storage at the intake was not possible, because of the location of the Southern California Edison power house, Kern River No. 1. On the intake side of the river and directly over the intake site, is a very dangerous mountain slide, from which during the rainy season blocks of rock rolled down to so great an extent that it was necessary to have a watchman constantly on guard to warn the workmen. For the same reason the intake structure was designed to provide a cushion of loose fill over its top. The structure is part of the dam, and has two 6-ft. sluice gates, one in front of the rack bars to remove coarse material, and the other behind the rack bars to clean the sand trap.

The two headgates are built up of timber and steel and are operated by threaded stems. The dam is 140 ft. long, 6 ft. wide, and 15 ft. high, with buttresses and 30-ft. apron. Flashboards, 8 ft. high, are so designed that in case of flood by releasing one timber they go out. They can be removed one at a time by a traveling chain block, supported by a two-span steel bridge over the dam.

As soon as the old plant was shut down, a cofferdam was built around the old intake and the new structure rushed to completion before the spring floods. When the tunnel was completed, in the early part of the following summer, the entire river was diverted through the tunnel and the dam built after the powerhouse was on the line, and while the rest of the job was being salvaged and cleaned up.

Enlargement of Tunnel—The tunnel work was the major part of the job and consisted of enlarging the old tunnel from 6 ft. 6 in. x 6 ft. 6 in. section to 13 ft. 6 in. x 14 ft. section. The new tunnel is a pressure tunnel. There are eight adits in the 8,300 ft. and as none of them is very long, all but two were enlarged, some of this work being done before the old tunnel was unwatered. After a careful study of surveys and costs, it was determined that the best plan would be to follow the line and grade of the old tunnel, thus using it as a pioneer. The ground encountered was a very blocky granite with many seams of quartz or mud but was entirely dry.

From Fig. 1 may be seen how access was had to the adits and from what points the work was carried on. The original flume was located approximately on the same elevation as the tunnel floor, and provided an excellent path from adit to adit and a bench on which to lay the 4-in. air line and 3-in. water line, with branches at each adit.

The old plant was shut down Jan. 28, 1921, and immediately a 3-ft. gage track of 25-lb. rail and 6 x 6-in. ties was laid the entire length of the tunnel. As all equipment was chosen so that it could be passed through the old tunnel, it was distributed at once and work started from all points of attack at the same time.

FIG. 2. LOOKING UPSTREAM FROM POWER HOUSE SITE

From this picture may be obtained a clear idea of the topography of the canyon and of the material through which the tunnel was driven. The lengths of penstock are lying close to the end of the tunnel section. On the right bank, looking at the picture, may be seen the road over which concrete materials were hauled to the mixing plant at Adit Five.

FIG. 3. LOOKING DOWNSTREAM FROM CANYON WALL

This view shows how abruptly the canyon ends at the power house site. On the right, adjacent to the power house, is shown Camp One, with headquarters office and living quarters. On the left bank are the machine shop, air compressors, and storehouses. The incline railway on the right slope provides access to the tunnel entrance.

At first an attempt was made to drill radial holes, using stopers for the roof, but the loose rock fill behind the concrete walls caused the steel to stock so badly that despite the advantage of being able to drill continuously ahead of the shooting and mucking, this method was abandoned. In conjunction with the radial drilling, an attempt was made to trap the muck but as it was necessary to build the traps too low for traffic to pass under it, this likewise proved unsuccessful.

A full heading was finally adopted with twelve to fifteen 15-ft. holes to the round, the muck being shot down on the track. All the mucking was done with Shuveloders, which, to their great advantage, worked on the main track instead of the usual sections.

Because of the pioneer and the very blocky ground, it was impossible to shatter the rock into small pieces. As a result the shuveloders were forced to handle material much heavier than that for which they are designed, but contrary to all expectations, after sev-

FIG. 4. GENERAL VIEW AT INTAKE
Note the loose rock in the canyon walls. At Camp Three, a short distance below this point, these were 1,000 ft. high and rock falls were an everpresent danger. On one occasion two bunk houses were partially wrecked by 5-ton blocks.

eral improvements and reinforcements were made, they did the work very satisfactorily.

Two, and in some cases three, headings, about 250 ft. apart, were worked on each side of an adit, so that while one heading was being drilled another was being mucked, thus making both operations practically continuous. Because of the excellent ventilation made possible by the numerous adits and the pioneer very little delay was caused by powder smoke. It was possible, therefore, so to plan the drilling and shooting in the several headings that progress depended upon the rate of mucking, which, during the last thirty days, amounted to 120 lin.ft. of tunnel per 24 hours. In order to keep four shuveloders working under such constant and severe service it was found necessary to have two other spare machines ready at the adits to replace a breakdown.

Five-ton electric locomotives, equipped with storage batteries and 2-yd. steel side-dump cars constituted the hauling equipment. No trolley was used; neither were the batteries removed from the locomotives while being charged at the adits, as enough equipment was provided to have at least one unit always on charge. The time of charging was about three hours. The batteries gave no trouble whatever, and in one instance, when a locomotive was lost over a dump 200 ft. high, it was necessary to go down to the river and open the switch, as the wheels were still spinning on the rocks. When hauled back to the tunnel this unit immediately resumed work without repairs.

In timbering three and five segment sets were used. Special spacing of the crown bars was necessary to provide for the concrete delivery pipe that would be used later. As a whole, very little lagging was done, but in one place already mentioned it was necessary to caulk with straw to keep the fine dirt from sifting in.

It was difficult to determine the proper tunnel section for use in the different parts of the tunnel. From an examination of the old tunnel it was evident that some parts would surely need lining, and these were driven to a lined section. Other parts might look as if they should be unlined, but after enlargement would show up dangerous ground. As a result the section was changed many times in order to avoid unnecessary lining and at the same time to avoid driving unlined sections which would need concrete. This resulted finally in three finished sections: one unlined; one lined to a size much over capacity, this being used for short lengths where the unlined section was not considered safe; and third, the lined section.

Concreting Tunnel—It was decided to do all the concreting from one plant, located approximately opposite the middle of the tunnel. Adit 5 was chosen because the muck dumped there was of good quality granite, and this material was used in concreting the tunnel.

The plant (Fig. 5) was built on the 45-deg. slope of the mountain, the inclined railway being built with its lower end at the road, thence across the river and up the slope to the storage above the mixer. A branch from the crushing plant led into this railway through a switch operated by the hoist runner by means of compressed air. The crushing plant was located at the bottom of the muck pile and consisted of two crushers and a revolving screen. Rock was fed into it with a scraper. A self-dumping car carried the material up the incline to the storage bins, made by building a timber wall across a deep ravine. Below this storage was located the mixer, cement bin and sack cleaner. A material platform was built along the road at the lower end of the incline where cement, lumber, and equipment were delivered by truck.

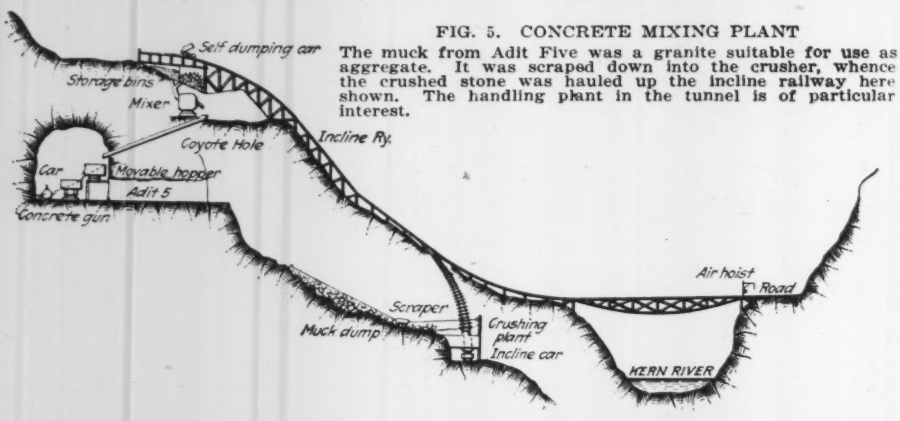


FIG. 5. CONCRETE MIXING PLANT
The muck from Adit Five was a granite suitable for use as aggregate. It was scraped down into the crusher, whence the crushed stone was hauled up the incline railway here shown. The handling plant in the tunnel is of particular interest.

From the mixer the concrete flowed down an inclined shaft through an 18-in. pipe, about 30 ft. long, to a hopper in the tunnel. This hopper traveled on a track so that its six 11-cu.ft. compartments could each in turn be spotted under the pipe. The bottom of this hopper was built on a slope and had the outlet gates of its several compartments so arranged that as a car was spotted one operation discharged the concrete into the six compartments of the cars. The car bodies were exact duplicates of the hopper, except that they had an individual sliding gate for each compartment. [For a detailed description of this plant see *Engineering News-Record*, April 27, 1922, p. 686.]

From the cars the concrete was discharged directly into the pneumatic guns, each compartment holding a gun batch of 11 cu.ft. Two guns were used, each consisting simply of a huge cylinder, with a piston, which forced the concrete into a 6-in. pipe, through which it was forced by compressed air into the forms. They were simple and efficient machines and gave no trouble whatever.

During excavation, space was left for the six-inch pipe to lie on top of the timber segments between crown bars and directly over center line. One of the difficulties encountered was in the removal of the pipe as the forms filled and to facilitate this the pipe was cut into 5-ft. lengths, connected by special quick-acting flange couplings. As a further aid the reinforcing steel in the crown of the arch (see Fig. 6) was specially designed.

As the concrete was discharged from the pipe against either a bulkhead or the concrete of the previous run, it flowed down into the walls and as these filled began to pack into the arch. By deflecting the pipe slightly the entire section was filled, after which the sections of pipe were removed.

Plugging of the pipe was practically eliminated by using aggregate not over one inch, by using bent pipe instead of ells and by keeping the gun close to the forms. The greatest difficulty experienced was the hardening of the concrete in the cars after a long haul. It was found that for a distance of less than 3,000 ft. there was little trouble, but for hauls between 3,000 and 4,800 ft., the maximum length, the concrete would not flow readily from the cars. This difficulty was found to be greater with a concrete having excess water or an aggregate deficient in sand.

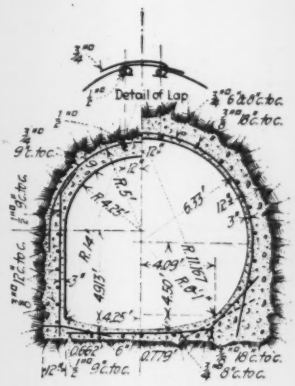


FIG. 6. CROSS-SECTIONS OF LINED TUNNEL

The normal lining is shown in the left-hand or B section. The right-hand or C section was used in short lengths of tunnel which had first been driven to an unlined section and then considered to be unsafe without lining.

Because of the two different cross sections in concrete, two sizes of forms were necessary, these being built of wood and oiled to prevent adhesion of concrete. One hundred and eighty feet of forms were needed for each gun, 60 ft. supporting the previous day's pouring, another 60 ft. receiving the day's pouring and a third being set for the next day. Reinforcement was placed ahead of the forms and supported on the tunnel timber.

The total volume of concrete placed in the tunnel was 13,750 cu.yd., 4,980 ft. of tunnel having been so lined. This was done in eighty 24-hr. days. The record days work was 285 cu.yd., and over a period of several days an average of 120 lin.ft. of walls and arch were completed in during a period of twenty-four hours.

Upon completion of the sides and roof the placing of the invert was started. A 400-ft. section was cleaned at a time, reinforcement placed and the 6-in. pipe strung out on horses. By experimenting, a nozzle was improvised that "shot" the concrete against the floor without much spattering, and there was no difficulty in shooting a 400-ft. section complete in 24 hours.

As a final precaution against leaking, all doubtful looking seams in the unlined section were cleaned and a heavy coat of "gunite" applied, these sections having been well underground and in good rock.

Forebay and Surge—The old forebay was in a large chamber excavated at the lower end of the tunnel, and in part of this the new concrete structure was built. It can best be described as a short piece of tunnel, approximately at right angles to the main tunnel. The regular tunnel forms were used. The tunnel entered at one side

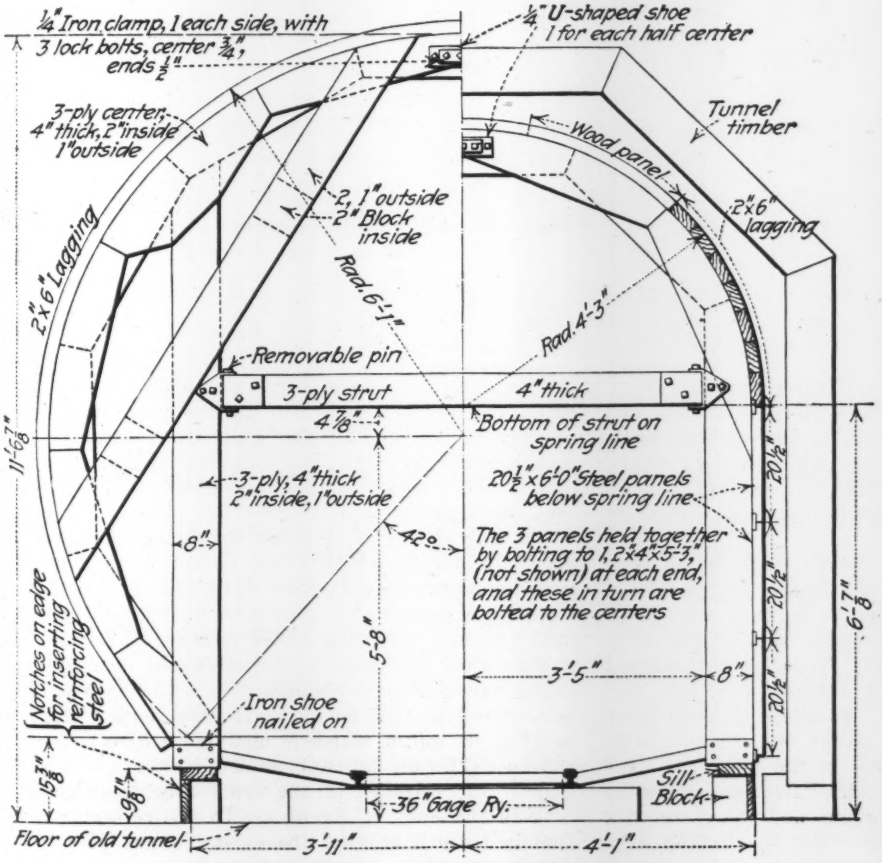


FIG. 7. FORMS FOR TWO TYPES OF TUNNEL LINING

and two penstocks entered on the opposite side. In one end a 36-in. sluice gate was provided. A sand trap and rock bars were installed to guard the machine against debris from the unlined section. In the remaining part of the old chamber were placed the two butterfly valves at the tops of the penstocks, one for the new penstock, 8 ft. in diameter, and one for the future penstock, 6 ft. in diameter, together with the 36-in. sluice gate and the air relief valves on the penstock. Surge was provided for by driving a 25-ft. diameter shaft to the surface about 60 ft. upstream from the forebay.

Penstock—For the present development, only one penstock was built, it being of riveted-steel plate, 8 ft. in diameter at the top, 7 ft. at the wheel, and 568 ft. long. It is supported on concrete piers or saddles and in addition to being backfilled is held by concrete anchors at the bends. This pipe was made up at the shop in 30-ft. lengths. No difficulty was experienced in handling these lengths in the field, although some of them weighed nearly 9 tons.

Power House—The power house site chosen was adjacent to the old plant, and was located on gravel and large boulders with enough clay to make a very tough conglomerate. On the power house side of the river is an easy slope for about 200 ft. from the waters edge, but directly opposite, on the warehouse side, is a vertical wall about 80 ft. high. As there was no room for wasting the muck on the power house side and as it was very inconvenient to get in the machinery and material, it was decided to build a cableway, extending over the lower end of the penstock, and the center line of the unit, thence across the river to the top of a 40-ft. tower on that side, so that trucks could be driven under it.

The cable was 2¾ in. in diameter and the span 636 ft. A special carriage was built on the job so that by using the block and hook belonging to the power house crane a 6-part line and 28-ton capacity was obtained. Because of the heavy and valuable machinery loads to be carried the stresses and sag were carefully computed. Observations taken when the 26-ton rotor was handled proved the computations to be accurate. The first duty of the cableway was to land the steam shovel for the excavation of the power house and part of the penstock, and to carry the muck across the river to the waste dump. As soon as the foundations were in the cableway began erection of the unit. This was carried on together with the erection of the building, so that by the time the concrete girders were ready for the 50-ton crane, the unit was complete and the crane was lowered directly to its rails by the cableway. After the roof was poured the final duty of the cableway was to handle the buckets of hot tar which was used as a roof covering.

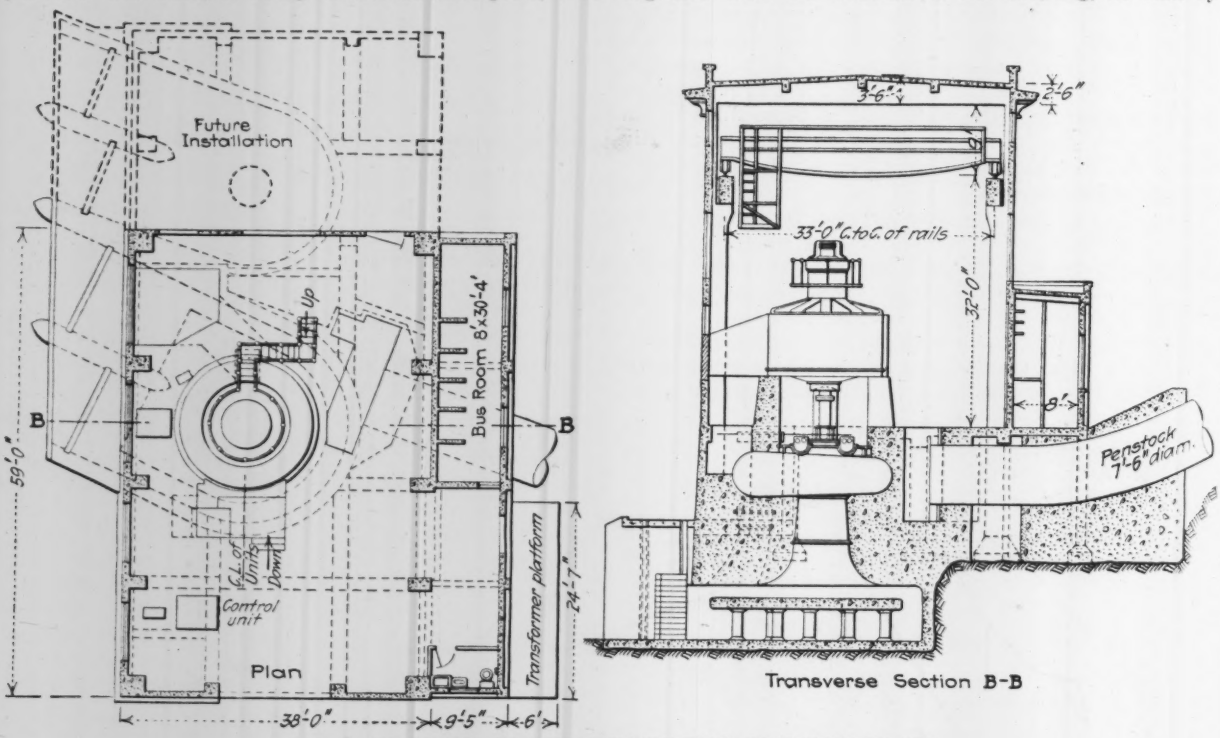


FIG. 7. PLAN AND TRANSVERSE SECTION OF POWER HOUSE
One 12,000-hp. unit only has been installed, but provision has been made for a future 6,000-hp. unit.

One unit only was installed but foundations are provided for one future unit and one end of the building is of temporary construction. The present unit with its auxiliaries consists of a 12,000-hp. Francis type vertical turbine, operating under a head of 230 ft., with a plate steel casing butterfly valve and pressure regulating valve, directly connected to a 10,600-kva. 11,000-volt, 60-cycle, 257-r.p.m. generator with Kingsbury bearing, on top of which is mounted a direct connected 864-kw., 125-volt, flat-compounded exciter. A White regainer was installed in the draft tube to increase the over-all efficiency of the unit. To insure better regulation in time of trouble, the exciter shunt field may be either separately or self-excited.

In order that power may be delivered from this plant

to the Southern California Edison Co., provision has been made also for generating at 50 cycles.

An unusual feature of this plant is that the water wheel is reached from the main floor, there being no pit. In order to accomplish this the generator is supported on a concrete ring, the top of which is 7 ft. above the floor. One advantage of this is that the governor, control units, switchboard and valve operating mechanism are all on the same floor, so that one operator and an oiler compose the entire crew.

Generator and transformer protection is provided by a bank of differentially connected relays with respective current transformers connected on the neutral of the generator and bushing type on the transformers. These relays open the generator switch, transformer switch and the field, the latter being so connected that it cannot open unless the generator switch opens. Each line is equipped with reverse power relays which are connected so that a short on one line will open that switch only, this selective action being necessary only when both lines are tied to the same station bus. For normal operation these relays are converted into plain overload relays by shunting the potential element contacts through a small knife switch mounted on the panel.

The control and lighting current is furnished by a small 25-kw., 125-volt, d.c. generator, direct connected to a 40-hp. impulse wheel with governor. Eleven thousand to 440-volt transformers provide station service for oil pump, valve operation, motor-generator set and camp requirements.

The low tension bus room is on the main floor into which the cables from the generator lead to the main switch, which is a 1,200-amp., 15,000-volt switch. Disconnects are provided for shunting around the switch in case it needs repairs. All of the low tension current transformers and main field switch are mounted on the generator.

The high tension bus is all of the outdoor type, supported on steel towers. The voltage is stepped up from 11,000 to 66,000 volts by a bank of 3,600-kva., single phase transformers, connected delta on the low side and Y on the high side, with the neutral grounded. The 11,000-volt current is brought from the bus room by 800,000 c.m. lead cables carried in a concrete beam. The switching equipment consists of three 300-amp., 70,000-volt, electrically operated oil circuit breakers, one for the transformers and one for each line. Disconnects provide a means of cutting out these switches for repair. A ring bus makes the whole flexible in order to handle both 50 and 60 cycles.

Camps, Water Supply and Sanitation—The construction of camps was started Dec. 1, 1920, the old operators' quarters being used as a nucleus from which to build the Headquarters Camp, No. 1, at the mouth of the canyon. The machine shop, saw mill, warehouse and material yard were located at the most advantageous point from which to distribute material, as shown in Fig. 1.

Camp No. 3 was built in the river bed, the buildings on platforms about eight feet above water, and the compressor plant on a high rock. No soil or sand was available for cesspools and lavatories, so it was necessary to haul out the kitchen waste in tanks and to build a concrete pit for the lavatory. This was burned out daily with straw and crude oil.

The water supply was pumped from the river by 3-in., 3-stage centrifugal pumps to 10,000-gal. tanks, located high enough to put pressure anywhere on the job. This water was all chlorinated, and excellent tests were obtained through the state laboratories.

Landslides from the walls of the canyon, 1,000 ft. high, were an everpresent source of danger, and many narrow escapes occurred, two bunk houses having been partially wrecked by 5-ton blocks of rock. This occurred at 7 p.m., while the men were in the bunkhouses. Two small rocks, which preceded the heavy slide, gave warning so that the men escaped.

All garbage was hauled to one point, where 120 hogs were kept, the job of hog-tender being combined with that of watching the powder magazine. Cans and other refuse not going to the hogs were thrown into a pit and burned. In spite of a temperature of 116 deg. in the shade, few trees and the absence of vegetation, there was very little discontent or sickness.

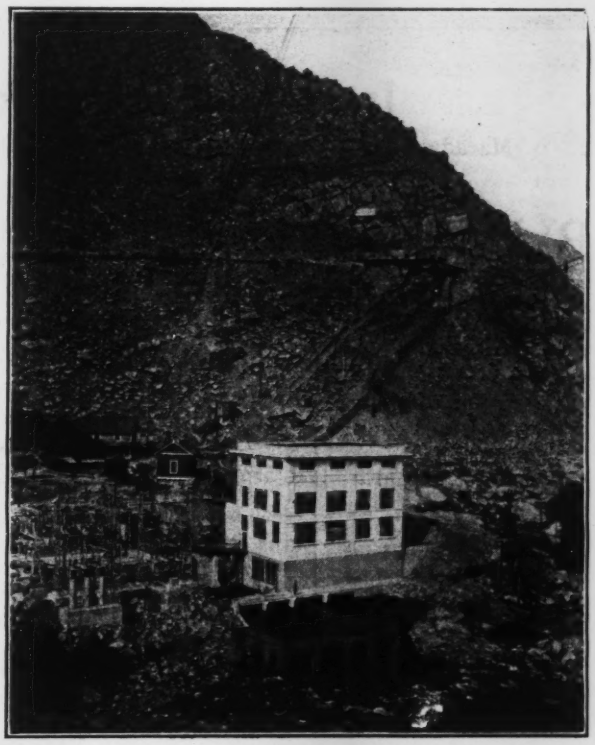


FIG. 8. COMPLETED KERN RIVER POWER HOUSE
Note to the left the high tension bus structure and overhead the cableway used to handle materials and equipment during construction.

A hospital was located at headquarters camp, and first aid stations placed at several points on the work.

The unit was put on the line Aug. 5, 1921, 248 days after authority was given to start construction.

The construction of this project was carried out under the direction of R. C. Starr, construction engineer of the San Joaquin Light & Power Corporation, whose organization consisted of H. K. Fox, superintendent, B. F. Jakobsen, designing engineer, J. D. McDougald, general foreman, Victor Rynning, general storekeeper, E. L. Fox, tunnel foreman, George Fisher, chief electrician, D. J. Pease, master mechanic, and W. B. McMillan, resident engineer. The concrete guns were furnished by the Universal Concrete Gun Co. and the power unit was manufactured by the Allis-Chalmers Mfg. Co. of Milwaukee.

Improving Improved Roads in Maryland

Macadam Roads Widened at Little Cost by Concrete Borders—Original Structure Conserved and Modern Pavement Produced by Resurfacing

BY MAINTENANCE and resurfacing, guarded by the regulation of traffic, the State of Maryland is conserving the full value of its original investment in waterbound macadam roads. By exactly the same methods it is protecting its investment in concrete and other high-grade roads. In fact the practice has been elevated to a principle of highway improvement on which are based all activities in keeping up a 1,700-mile state system. Principle and practice may be expressed as follows:

1. Limit the use of highways to vehicles having a gross weight of 10 tons.

2. Maintain every road in perfect condition.

3. Resurface every road as soon as it can no longer be made by maintenance to give perfect service.

Maryland's policy, which makes it necessary from time to time to improve her improved roads is fundamentally sound and correct. Under it she has become one of the "best roaded" states of the Union. The improvements which keep her moderate-priced roads continually up to date cost far less than the high type roads which elsewhere are being built to carry traffic no heavier than her roads carry. The Maryland plan starts with a relatively small investment in admittedly low-type road. By a process of gradual improvement, by selective treatment of the weak places, it builds up a better road from year to year, always conserving the bulk of the previous investment. It is a plan which is more like the French plan than is to be found anywhere else in the United States. It differs sharply from the method which attempts by expenditure of vast sums to build at once, forever.—J. N. Mackall, Chairman, Maryland State Roads Commission.

How the first requirement—perhaps the most important of all—was met, was described in *Engineering News-Record*, April 21, 1921, p. 666. A motor vehicle law was *enacted* and then *enforced*. It is in the same positive manner that maintenance and resurfacing are *planned* and then *carried out*. In brief, it is not the maintenance or resurfacing methods or the forms of structure employed, which make it possible for the Maryland roads commission to have conserved the full value of its original investment in roads, but it is the fact that *maintenance and reconstruction are performed*.

Development of Practice—Maryland began building modern highways in 1908 and in the years that followed it built macadam roads at first 12 ft. and finally 14 ft. wide, and following macadam, it built paved roads and some gravel roads until every county seat and every town with a population of 1,000, had an improved road connection with all the others. At the beginning of 1920 these improved roads had cost about $30,000,000. Some of the early ones were very cheap—they cost only $10,000 a mile. They had all been well maintained from the time they were built. Meanwhile a serious traffic problem had developed with the use of motor trucks and unrestricted vehicle loads. Two solutions presented themselves: (1) Let big truck loads continue and perhaps grow larger and let them smash the old roads and when this had happened build new hard-paved roads designed to carry the heavy trucks, which was to say, let the truck owners destroy the original $30,000,000 investment, or (2) reduce the truck loads and hold them down to the capacity of the old roads kept up to full strength by perfect maintenance, and when better service was required than the old roads could give, widen and resurface them, conserving all of the old structure. As has been indicated, the second solution was adopted. Maintenance and resurfacing are the operations.

Maintenance Practice—Perfect maintenance is not held imaginary by the Maryland road commission. No hole of any size is permitted to remain in the surface of any road. Holes are repaired, as soon as they appear, by patrolmen. Patrol maintenance is regarded

as a fundamental requirement of perfect maintenance. Another thing held fundamental is that construction and maintenance shall be under the same engineering direction. The district engineer when he builds a road in his district also maintains that road.

Technically the methods of maintenance do not differ largely from those everywhere in use. The difference is that the maintenance in Maryland is continuous and precise. The practice is no different than the theory. This idea of perfection in maintenance is being emphasized here because it is upon perfect maintenance as much as on exact control of traffic loads that the principle of improvement, which has been described, has its foundation.

With the best of maintenance there comes a time when the old road will no longer serve the traffic. It is wearing thin or having its edges raveled out or is cracking up to a degree where holding it in service any longer merely by maintenance is uneconomical and barely possible. Then, while the road has high structural value and can be built onto, it is set aside for resurfacing. The big contribution of Maryland to highway improvement structurally is the methods it has developed of resurfacing macadam and concrete roads as illustrated by the drawing and views of old and reconstructed roads reproduced herewith.

FIG. 2. A WIDENED MACADAM ROAD

This is a portion of the Frederick Road shown in half-section by Fig. 1. The 14-ft. road is now 20 ft. wide, 14 ft. original macadam, backfilled on the haunches, and two 3-ft. concrete shoulders. The dark streak down the middle shows the original undisturbed macadam.

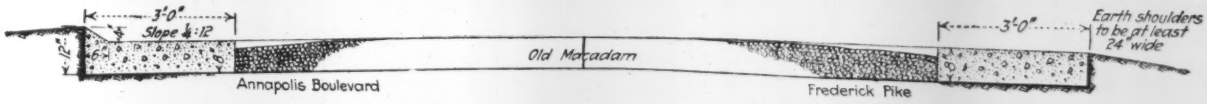


FIG. 1. TYPICAL SECTIONS OF WIDENED MACADAM ROADS

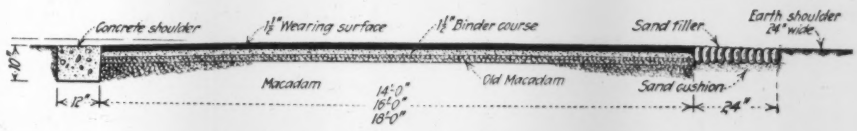


FIG. 3. MACADAM RESURFACED BETWEEN BORDER STRIPS

FIG. 4. MACADAM READY FOR RESURFACING

This is fairly typical of a macadam road considered to be ready for resurfacing, maintenance patching is becoming excessive and the edges are raveling. The same road widened by 12 x 10-in. concrete curbs and resurfaced with 3-in. of asphalt is shown in the photograph at the top of page 56.

Resurfacing Macadam—Two ways of resurfacing old macadam are practiced: (1) Construct along one edge or both edges of the old macadam a concrete strip as shown by Fig. 1 and the view Fig. 2, and at the same time raise the haunches of the old road crown with new macadam, or (2) widen the old macadam by concrete or cobble strips and resurface the macadam with asphalt between strips, Fig. 3 or over the strips, Fig. 6.

Considering the first method as depicted by Figs. 1 and 2, 12-ft. and 14-ft. roads have been widened to 20 ft. and in the process of widening the sharp crown—¾ in. on 1 ft.—of old style macadam roads has been cut down to conform to modern standards. Referring to Fig. 1, the surface of the concrete strips is about 2-in. lower than the pavement crown and from 2-in. to 5-in. higher than the surface of the old macadam at the edges. To fill in the haunch then, requires the addition next the concrete strip of a wedge of bituminous macadam 2 to 5 in. deep tapering off to a feather-edge.

Eminent satisfaction has been given by the resurfaced macadam construction. No difficulty has been had in holding the macadam in place. The new macadam in the sides thickens the old road where it is weakest. And of course the concrete curb not only widens the road but holds the old road from raveling at the edges.

In the second method of resurfacing macadam there is a true resurfacing process. Fig. 4 shows the appear-

ance of a macadam road when it is considered about ready for resurfacing. Sometimes the macadam gets in worse condition, but this is generally due to unusual circumstances. The photograph on p. 56 shows the same road resurfaced with 3 in. of asphalt between 1-ft. concrete curbs. Figs. 3 and 6 indicate other typical asphalt surfacings.

Ordinarily the 1½ in. asphalt binder is put directly on the macadam which is merely swept clean. In case the road has some pot holes, these are cleaned out and additional binder is placed in them and tamped to grade immediately ahead of the regular binder course. Except when additional stone is required, or where the cross-section is distorted or where the surface is corrugated the old road is not scarified. When scarifying

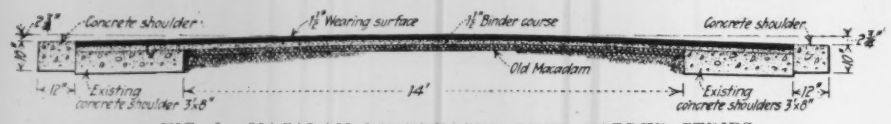


FIG. 6. MACADAM RESURFACED OVER BORDER STRIPS

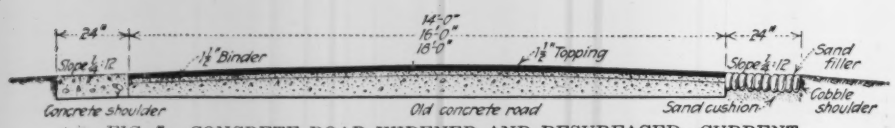


FIG. 7. CONCRETE ROAD WIDENED AND RESURFACED—CURRENT MARYLAND PRACTICE

is necessary new stone is added and the whole is waterbound and rolled. Scarifying retards resurfacing and costs about $5 per ton of new base in place. With bids for binder and tops running $1.40 to $1.50 a square yard and $9 per ton for extra binder, the scarifying increases disproportionally the cost and low cost is of course the compelling argument for the resurfaced road against new concrete roads. Bids for 10 x 12-in. concrete curbs run about $13 per cubic yard and for 8-in. x 2- or 3-ft. about $11 per cubic yard.

Resurfacing concrete—The general method of resurfacing old concrete roads is the same as for macadam roads. With the ordinary conditions of surface no roughening has been found necessary to hold the asphalt from creeping and it has been laid on grades as steep as 6 per cent. A typical section of resurfaced concrete road is shown by Fig. 7.

Traffic uses the roads during reconstruction. One concrete strip is built, using a portable one-bag mixer, and then the second. Half the road is always open to traffic. Unless the old macadam is scarified none of the operations is heavy and the volumes to be hauled are not large. Large equipment does not, therefore, encumber the operation and block the roadway.

Theory Developed—The practices recorded are the offspring of a matured theory of highway improvement. It is that roads can be improved only to be, later on, improved again—there is no permanent road. First roads of such cost as could then be afforded were constructed. These roads have earned their cost. By perfect maintenance and traffic regulation their original structural integrity still exists. On the original structure there can now be joined new construction which modernizes the old road and enables it at a fraction of the cost to give service for a number of years to come which is as satisfactory as a higher-type new road would give. The requirement of service to traffic is thus met until some future time when a further reconstruction or, perhaps, replacement is required.

Rusted Steel Chimney Repaired by Welding

Repair of a badly corroded steel smokestack at the plant of the Arbuckle Sugar Refinery, Brooklyn, N. Y., was accomplished by an unusual use of electric welding. The stack is 16 ft. in diameter at the top and 245 ft. high, and consists of ¼-in. plate a steel shell ¾-in thick (originally) at the top, lined with brick. Corrosion had been so active in its upper part during twenty years of service that the steel in many places was of hardly more than paper thickness, and rollers on a hoisting cage used to lower men and materials along the side of the stack went through the plate repeatedly.

It was desired to make repairs without putting the stack out of continuous service. The method finally used, with success, was placing new ¼-in. sheets directly over the sheets to be replaced, and butt-welding them to the adjoining plates at the vertical edges and welding them to the rivets of the ring seams. No method of riveting new sheets in place could be used, on account of the brick lining. When repairs by welding replacement were first contemplated, it was planned to burn out the old sheets one by one and replace them as they were removed, but it was found that this could not be done because the metal was so thin that the edges would not stand up.

The plates were about 5 x 9 ft. in size, weighing something over 200 lb. each. The principal difficulty in executing the work on this plan was caused by the height above ground, which bothered both the arc and the men. There was always enough air movement at this height to affect the arc or blow it out, and the welders found it hard to work efficiently, on an open platform. Both difficulties were disposed of by building a cage with inclosure on the outside so as to give practically sheltered conditions; the welders were then able to work almost as well as on the ground. The cage was about 7 x 9 ft. in size, and was suspended from falls attached to the top of the stack so that it could be raised and lowered like an elevator cage. The sheet to be attached was loaded into the cage and hoisted with the men. Air holes for pneumatic tools and the electric wires to the welding machines also went up and down with the cage. The work was carried out by the Electric Welding Co. of America, Brooklyn.

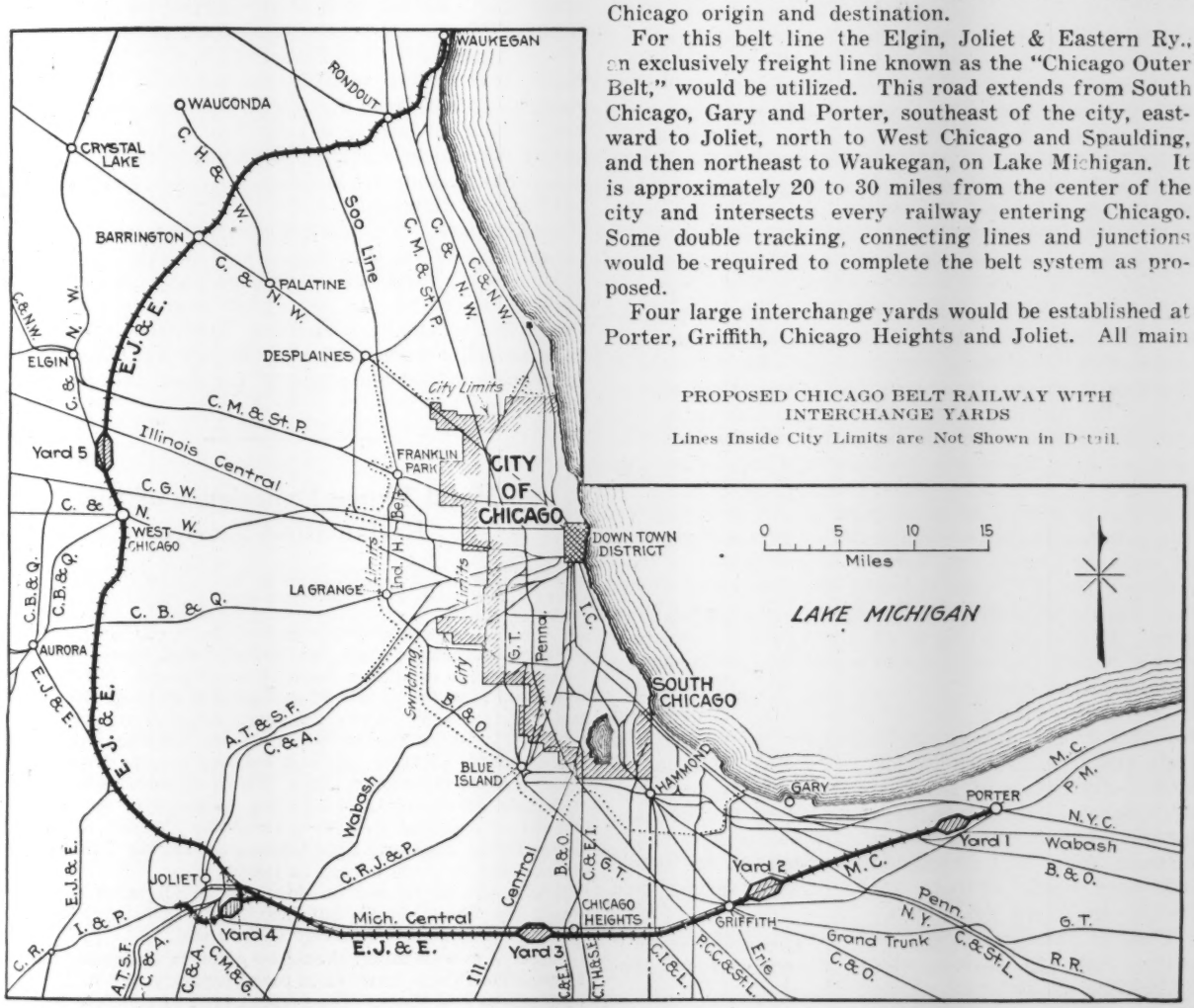
Riveted Pipe Relaid After 31 Years Service

The Los Angeles Water and Power Bureau recently transferred to the engineering department of that city for use on the emergency sewage disposal project, 17,000 ft. of 44-in. riveted iron pipe about ⅛ in. thick, which has been in service thirty-one years. The pipe is reported to be in uniformly good condition.

Another Relief Plan for Chicago Terminal System

Belt Line and Interchange Yards to Keep Through Cars out of Local Facilities—Three City Passenger Terminals

TRANSFER of through freight cars around Chicago and the concentration of all car interchange business at a few large outside yards, together with joint operation of the entire terminal district, are the features of a recent report to the National Association of Owners of Railroad Securities by the Board of Economics and Engineering. Col. F. A. Molitor is chairman of the Board, and the detailed studies for the report have been made by W. L. Darling, one of the members. The general scheme is illustrated by the accompanying map.



PROPOSED CHICAGO BELT RAILWAY WITH INTERCHANGE YARDS

Lines Inside City Limits are Not Shown in Detail

Under present conditions 23 separate companies operate 29 railroads entering the city. Within the city limits there are 16 independent belt or industrial lines, 80 points (or more) where freight is interchanged, 184 freighthouses (69 in the business district), 120 freight yards and 65 engine terminals. Of a daily traffic of 27,000 freight cars in and out, 14,000 cars, or 54 per cent, are through cars. Transfer from one trunk line to another by one or more belt lines involves a delay of 13 to 18 hours at each transfer point. As a general average, according to the report, there is an aggregate delay of about 58 hours to both through and local business in passing through the city. This time is exclusive of that consumed in train movements.

Belt Line and Interchange Yards—Under the plan proposed, all through cars would be diverted around the city by an outside belt line, thus keeping the local yards and terminal facilities clear of this business and permitting their development for adequate service, besides releasing a considerable area of ground for more productive use. All the present 80 interchange points would be eliminated and there would be retained only the terminals and facilities required for freight of Chicago origin and destination.

For this belt line the Elgin, Joliet & Eastern Ry., an exclusively freight line known as the "Chicago Outer Belt," would be utilized. This road extends from South Chicago, Gary and Porter, southeast of the city, eastward to Joliet, north to West Chicago and Spaulding, and then northeast to Waukegan, on Lake Michigan. It is approximately 20 to 30 miles from the center of the city and intersects every railway entering Chicago. Some double tracking, connecting lines and junctions would be required to complete the belt system as proposed.

Four large interchange yards would be established at Porter, Griffith, Chicago Heights and Joliet. All main line freight trains would terminate at and start from these yards, interchange being made here and over the belt line. Local cars would be handled in full trains between these yards and the city terminals. North of Joliet the present outlying yards can be used conveniently, but later a fifth large yard would be provided at West Chicago.

City Freight Terminals—Consolidation of all city freight business in the district between State St. and the (proposed) straightened river channel south of

Polk St., as recommended in the Wallace plan of the Chicago Railway Terminal Commission (see *Engineering News-Record*, May 19, 1921, p. 845), is suggested for further study.

Removal of all freighthouses and team yards in the congested districts to outside locations has been studied, but the Board has not arrived at a definite conclusion. Trucking by container or other method at 25c. per ton per mile would cost $2.50 with facilities located ten miles distant, which amount, the Board states, would exceed the fixed charges saved. It is proposed to consolidate all city L. C. L. freight into trap cars of 11 tons capacity and possibly to use flat cars with containers. These latter should be loaded for firms and individuals in order to avoid rehandling of freight through the downtown freighthouses. A greater saving would be effected, according to the report, if the containers were operated between the group yards and the city.

Unit Operation—Although unified control and operation would be necessary to the effective use of the proposed plan, the report takes the position that such control does not necessarily involve disturbance of existing ownership. Single administrative control is required and it is considered that this may be secured by lease or operating agreement. The improved operating methods could be put into effect on completion of the group yards, the improvements along the Elgin, Joliet & Eastern Ry. and the necessary connections.

Passenger Terminals—Consolidation of all passenger traffic at three of the six existing stations, as proposed by the Board, would retain the Chicago & Northwestern, the Union and the Illinois Central stations. In selecting the roads to use the respective stations, consideration has been given to the tentative plan of the Interstate Commerce Commission for grouping all the railways of the United States into nineteen systems. An advantage in the proposed arrangement is that the roads would be grouped together at outlying points and further consolidated as they approach the city, thus reducing the number of crossings and developing trunk lines for passenger business only. Furthermore, some of the present circuitous routes within the city limits would be shortened by three to nine miles.

In the final plan of the terminal district as prepared for this report, passenger lines have been separated from the freight lines as far as possible in order to avoid interference of the two classes of service. For example, since the Santa Fe and Chicago & Alton are parallel (but on opposite sides of the drainage canal) between Joliet and Chicago, it is proposed to handle passenger traffic of both roads on the former and freight traffic on the latter.

Cost of Terminal Project—A summary of the estimated cost and savings shows a net cost of only $5,000,000 as follows:

Changes and new works proposed by the Board of Economics	$47,000,000
Rearranging city freight facilities and straightening Chicago River (as in the Wallace plan)	43,000,000
Total	$90,000,000
Value of ground space released and air rights retained	$85,000,000
Net cost of combined improvements	5,000,000
Net annual saving in operating costs and fixed charges	16,000,000

This estimate does not include the value of 24 hours saving in time on all through and local business; the savings due to the use of three or four passenger terminals in place of six; saving in property by abandoning certain facilities and the reduction of future investment by reducing requirements for electrification, track elevation and other terminal expenditures. The report states that one of the most important savings under the new plan is due to the more efficient use of the power employed in the terminal district. Probably not more than half and certainly not more than two-thirds of the capacity of the engines is now utilized because of the frequency of long switching movements with short trains.

Improvement works covered by the Board's estimate of $47,000,000 include the following: Four group yards, $36,000,000; car repair shop, $1,000,000; 33 miles of second track, $1,650,000; new double track connections and connecting lines, $6,300,000.

Earlier Project—In many respects the project described above is similar to one put forward ten years ago by L. C. Fritch, then chief engineer of the Chicago Great Western Ry. (now vice-president of the Rock Island Lines). This earlier project (see *Engineering News*, May 9, 1912, p. 902) was naturally on a smaller scale. At that time the Elgin, Joliet & Chicago Ry. was considered too far out for use in transfer service and a 50-mile belt composed mainly of existing lines was to run from South Chicago to Mayfair, keeping outside of Hammond, Blue Island, La Grange and Franklin Park. Three large interchange yards were to be established on this belt. The number of cars to be handled in and out of Chicago daily was taken at 30,000, of which 33 per cent were interchanged. Facilities capable of handling 3,000,000 interchange cars annually were estimated to cost $15,000,000 and to require $2,000,000 annually for fixed charges.

Metal Flume Experience of the Reclamation Service

Summary of a questionnaire on the design, construction and life of metal flumes at six projects of the U. S. Reclamation Service by Julian Hinds in "Reclamation Record" for April.

METAL sheets galvanized, manufactured, installed, and maintained as were the earlier metal flumes will last under average conditions from 10 to 12 years. No data are available as to the weight of galvanizing on these old sheets, but they probably carried not more than 1.5 oz. per square foot. The later flumes with heavier coatings and with more careful painting and maintenance may be expected to show a materially longer life. There appears to be no appreciable difference in the lasting qualities of the various brands of iron and steel used for flume sheets. Rough interior flumes appear to deteriorate more rapidly than smooth flumes, due to disturbances at joints.

Light silt in suspension does not in all cases seriously erode the flume sheets, but heavier particles may destroy the sheets in a comparatively short time.

Careful consideration should be given in designing flumes to possible future increase in canal capacity and to the size of washers and shoes. The present type of concrete footing is generally satisfactory. The size of footing should be increased for soft soils, and special care should be taken to make footings in seeped locations resistant to alkali. Trestle timbers should be of ample size and should be protected with paint or creosote. Posts are likely to rot at the bottom.

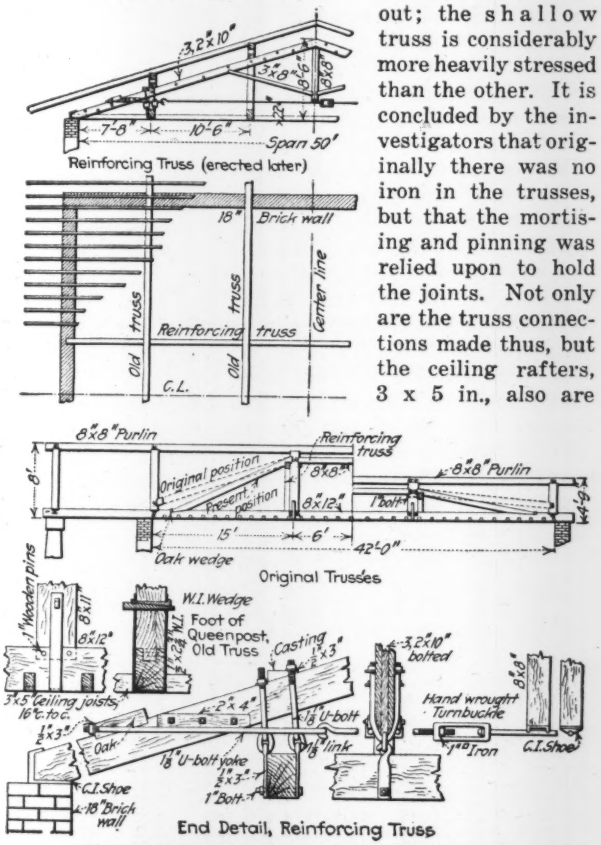
Sheets should be painted before the galvanizing is destroyed, with a coat of water-gas tar followed by one or two coats of coal tar, and a coat of coal tar should thereafter be permanently maintained on the sheets by repainting at intervals of from one to three years.

Timber Roof Framing in Arkansas Capitol is 87 Years Old

Originally No Iron in Trusses, Mortising and Pinning Hold Joints—Bottom Chords Are Heavily Stressed

AN INTERESTING example of old wood roof-truss framing, found in the roof over the old senate chamber of the Arkansas State Capitol, was examined recently by Philip B. Hill and N. B. Garver on the part of the Arkansas Chapter of the American Association of Engineers, at Little Rock. Essential features of the truss framing are shown in the drawing herewith, reproduced from blueprints accompanying their report.

The room covered by the trusses is 42 x 50 ft., inside. The original trusses, spanning in the 42-ft. direction or parallel to the ridge line of the peaked roof, are of different depths, respectively 8 ft. and 4 ft. 9 in. out to out; the shallow truss is considerably more heavily stressed than the other. It is concluded by the investigators that originally there was no iron in the trusses, but that the mortising and pinning was relied upon to hold the joints. Not only are the truss connections made thus, but the ceiling rafters, 3 x 5 in., also are



ROOF TRUSSES, ARKANSAS STATE CAPITOL

The original trusses were erected about 1835. Two reinforcing trusses transverse to them were put in later, apparently because the original trusses sagged.

mortised into the bottom chords of the trusses. There are other peculiarities; for example, the end posts do not come directly over the walls but are offset inward, which throws a heavy stress into the bottom chord.

Originally the batter posts appear to have been framed into the end posts, but subsequently they were changed to frame into the bottom chord; the stub is still found in one of the end posts, and the corresponding mortises in other end posts. On account of the weight of the ceiling, the joint at the foot of the queenpost broke after construction, and the post was then attached to the bottom chord by a wrought-iron strap stirrup, connected by wrought-iron wedges, without bolts.

Later still, apparently, two trusses spanning in the other direction were put in to support the old trusses, presumably because they sagged. The old trusses are of hewn cypress timbers, while the reinforcing trusses are of pine. The top chord of the reinforcing trusses consists of three 2 x 10-in. boards. Other details of these trusses (shown by the detail sketch) are equally interesting. Part of the batter posts of the old trusses was cut away when the reinforcing trusses were installed, reducing their section about one-half, but the suspension from the new trusses probably relieved them of most of their stress.

County Road Work Discredited in Nebraska

COUNTY construction of highways is generally discredited in a legislative committee report published by the Nebraska Department of Public Works. So deplorable a lack of records and proper accounts was found in all but a few counties that the committee discredits all costs per mile which have been claimed and recommends that:

1. Complete segregation be made of state and federal-aid roads from the county roads, both as to construction and maintenance, the complete responsibility for the construction and continued maintenance of state and federal highway system being in the Department of Public Works, and a like responsibility for county roads in the County Board. This suggestion will fix the responsibility, eliminate the necessity of co-operation between so many branches of the government, and centralize the authority where it may be exercised.

2. Every county should have a county highway engineer with a longer term than two years of office, probably four years. There should be definite qualifications fixed before an engineer can become eligible to this office. It is very difficult for the county boards to ascertain in advance whether they are securing competent men and experiments are costly.

3. The highway engineer should be given ample authority in matters pertaining to the construction and maintenance of the county roads, and be charged with the responsibility therefor. We believe that he should have absolute authority of the proper construction and maintenance of all county roads. This would contemplate the removal of authority from the township board, but it would result in a more centralized responsibility and opportunity.

4. That each county should lay out a system of highways for itself just as the state laid out the system of state highways, and that all work done by the county should be done so as to fit into this plan of operation. The piecemeal work which has been done in many places is largely wasted.

5. We believe that beyond a doubt some uniform standard of accounting for expenditure should be required of every county in the state. The present law we regard as ideal, but if it is too cumbersome then it should be simplified, but in all events the county should keep such a uniform accounting system. With the expenditure of such large sums of money, this is highly important.

6. We believe that it would be a benefit to the State if the counties were required to submit quarterly reports of their expenditures relating to highway matters to some central agency, not for the purpose of auditing them or burdening them, but in order that there may be centralized and tabulated information available as to the mileage and costs, and the general condition of the roads in every county in the state. It seems to us that this information is necessary to intelligently deal with the highway problems of the future.

Effect of Elevation Upon Run-Off from Catchment Areas

A Study of Data for Northeastern Streams to Aid in Estimating Run-Off from Certain Areas in New Jersey

By Allen Hazen
Civil Engineer, New York City

IN THE semi-arid west, catchment areas that are high in elevation produce the most water. The elevation of the catchment area to be used is one of the first things to be considered in any project. The relation between elevation and run-off is not a simple one. Other matters are involved. For one thing, the side of the mountain towards the ocean usually produces more water than the side away from it.

Rainfall data are more numerous than run-off data; and the studies and literature of the effect of elevation have largely related to rainfall. But rainfall does not

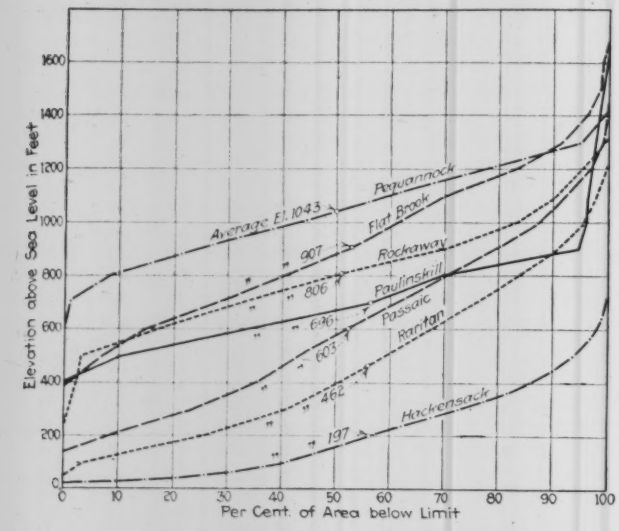


FIG. 1. ELEVATIONS OF NEW JERSEY CATCHMENT AREAS

tell the whole story, for with high elevation the evaporation is less and the run-off greater from the same rainfall. It also seems to be true that on an average the higher areas are steeper and drain more rapidly and completely than lower and flatter ones, and the run-off is a greater percentage of the rainfall. The effect of elevation may, therefore, be much greater on run-off than it is on rainfall.

The effect of elevation upon rainfall and run-off has been less generally recognized in the eastern United States. The differences in elevation, although considerable, are less marked than in the west. The run-off from the lower areas are greater relatively and the differences due to elevation are more easily lost sight of among differences produced by other causes.

The accompanying table gives run-off data for northeastern streams recently collected by the writer as an aid in estimating the probable run-off to be expected from certain New Jersey areas. The average elevations of the areas were ascertained and are shown in the table.

The average elevations of the areas were obtained by measuring the areas above selected contours and making

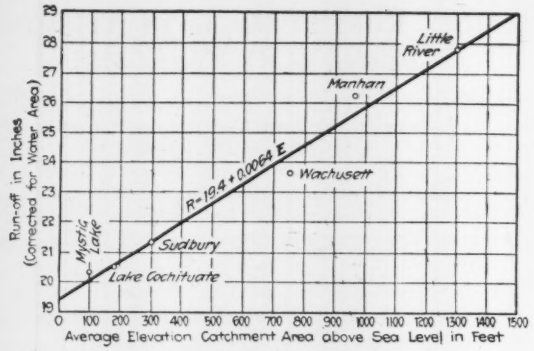


FIG. 2. MASSACHUSETTS ELEVATIONS AND RUN-OFFS

a mass curve of the results. Such a plotting for certain New Jersey areas is shown by Fig. 1. This, in turn, is planimetered and the average elevations are calculated from the results. For these areas the state maps, one mile to the inch, were available and the results may be taken as practically exact. For some of the larger areas in other states corresponding maps were not available, and a small-scale United States Geological Survey map, with 500-ft. contours, was used. These results are roughly approximate only.

The first step in the procedure was to make a correction for the areas of water surface where they existed. For the Massachusetts supplies the run-off records represent the actual conditions, including reservoir areas. At Hartford, Conn., and at the Ashokan reservoir of the Catskill water supply, New York City, gaging stations on the main tributary streams above the reservoir were provided when the dams were built; and records so obtained are from areas without water surface. In the latter case the records from both stations were consolidated by the writer. Because of additional loss by evaporation from water areas a correction must be applied to bring all to the same basis.

RUN-OFF RECORDS FOR NORTHEASTERN STREAMS

	Year Ending	Average Per Cent Water Surface	Average Elevation Ground Surface	Actual Run-off Inches	Run-off Corrected For Water Surface	Run-off Corrected For Elevation 0.0064 x El.
Merrimack	1916	2.5	771c	20.57	21.0	16.1
Connecticut	1899	0	1,172c	19.58	19.6	12.1
Scituate	1920	2.0	457b	28.03	28.4	25.5
Mystic Lake	1897	3.6	109b	19.85	20.4	19.7
Cochituate	1920	7.2	180a	19.49	20.5	19.3
Sudbury	1920	4.8	300a	20.62	21.3	19.4
Wachusett	1920	5.3	750a	22.83	23.6	18.8
Manhan	1920	0	965b	26.22	26.2	20.0
Little River	1920	1.4	1,293b	27.52	27.8	19.5
Nepaug	1920	0	754b	24.91	24.9	20.1
East Branch	1920	0	1,022b	28.13	28.1	21.6
Esopus	1920	0	1,984b	32.07	32.1	19.4
Schoharie	1920	0	2,148b	27.80	27.8	14.0
Rondout	1920	0	1,655b	31.09	31.1	20.5
Catskill	1920	0	1,580b	17.45	17.4	7.3
Hudson	1916	1.57	1,226c	23.50	23.8	16.0
Croton	1920	4.2	600a	22.60	23.3	19.5
Pequannock	1918	4.0	1,043b	26.99	27.8	21.1
Delaware*	1920	0	1,458c	23.12	23.1	13.8
Passaic	1920	1.42	603b	25.75	26.0	22.1
Nishaminy	1912	0	345b	22.65	22.6	20.4
Perkiomen	1912	0	540b	22.58	22.6	19.1
Tohicken	1912	0	500b	27.41	27.4	24.2
N. Br. Susquehanna†	1920	0	1,443c	23.77	23.8	14.6
Susquehanna	1916	0	1,295c	21.12	21.1	12.8

a—New England Water Works Association Committee.
b—H. W. & F.—U. S. Geological Survey maps. 1 mile per inch, exact.
c—H. W. & F.—U. S. Geological Survey maps, 37 miles per inch, rough.
* Above Port Jervis.
† Above Binghamton and near it.

A rough approximation was sufficient. This was reached by assuming that 3 sq. miles of water area produce as much run-off as 1 sq. mile of land area. A revised run-off figure for land only was reached on this assumption.

A rapid inspection of these figures after this correction indicates that the higher areas produce more water than the lower ones. The differences are so great

FIG. 3. RUN-OFFS FOR NORTHEASTERN UNITED STATES

Parentheses are at centers of gravity of catchment areas. The figures outside the parentheses are actual run-off; figures within the parentheses have been adjusted for altitude and water area.

as to suggest the desirability of bringing the effect of elevation into the calculation in some definite way. Even though the first attempt leads only to a rough approximation, the results may be more accurate than would otherwise be reached. Rainfall data were not used. It was thought to be better to use the run-off data only. Although less numerous, the run-off records go directly to the heart of the matter as rainfall records do not.

This study was particularly important for the New Jersey estimates because the best record of stream flow in the state is that of the Pequannock River of the Newark water supply; and as it happens this area is also the highest in elevation of all the New Jersey areas there would be a danger of over-estimating the yield of the other areas if Pequannock records were used without correction.

To get a first general idea of the effect of elevation upon run-off a number of Massachusetts records were used. These were selected because there were more long-term records in a limited area than elsewhere, and the differences in elevation were enough to be significant. The values for mean run-off were plotted against average elevation in Fig. 2. The points lie almost in a straight line. It is true that the records from the different areas do not cover the same period of years, and strictly the comparisons should be made for the same period. Limiting the data to those contained in a single period throws out the greater part of all those used. Those that remain after this treatment support the general result shown in Fig. 2, and they are not reproduced.

The position of these catchment areas and of all the others shown in the table are shown in Fig. 3, which is reproduced from the New Jersey report. Parentheses on this map are plotted approximately at the centers of gravity of the respective areas.

In considering these Massachusetts areas, the map being before one, there is no apparent reason why the precipitation for Manhan and Little River should be greater than for Wachusett and Sudbury except that the elevations are greater. In fact, if the elevations were all the same one might expect that the areas nearer the ocean would produce somewhat more water than those farther from it.

The effect of elevation found by this diagram is therefore apparently a minimum below which the true value is not to be expected. Whether the true value is greater than indicated cannot be established from this evidence.

The line in Fig. 2 that connects the points showing these data indicates an average relation between elevation and run-off of 0.0064 in. of run-off per annum for each foot of difference in average elevation. This figure was taken provisionally as a basis for adjustment of all of the data used in this study.

The next step in the procedure is to correct the average run-off for each station for elevation by deducting an amount equal to the elevation multiplied by 0.0064.

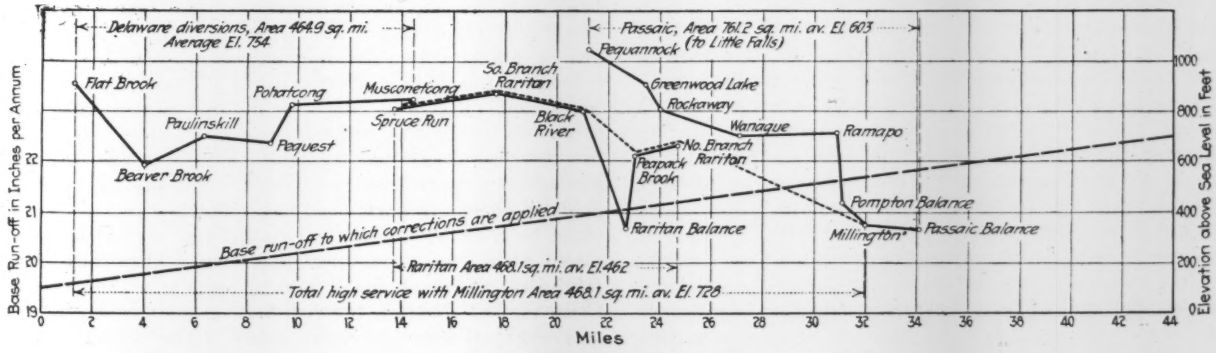


FIG. 4. ASSUMED RUN-OFFS

Used as basis for applying altitudes and water area corrections. Circles represent projections of center of gravity of catchment areas onto vertical plane through north line of State of New Jersey from catchment areas.

The figures so corrected for both water surface and elevation are shown in the last column of the table and in parentheses representing the position of the various catchment areas in Fig. 3.

It was found that the adjusted values show much less variation between stations than the values for total run-off. To illustrate, Esopus Creek, part of the New York City supply, and one of the highest areas, has the highest rate of run-off shown in the table, but the corrections bring it down to the level of the Croton

River with which it may be compared. On the other hand, the record for Catskill Creek shows a marked variation. Although high, its run-off, after correction, is much lower than neighboring areas. Schoharie Creek also shows this in less degree. This is no doubt accounted for by the fact that these streams lie on the far side of the Catskill Mountains, so that a somewhat similar effect is obtained to that observed in the west where the side of a mountain away from the ocean produces less water.

With the map before us showing the adjusted values for all the areas, base values were selected for the areas for which estimates were to be made. In Fig. 4 are shown the base values in diagrammatic form. These base values were then put through the reverse processes of adjustment. To each was first added an amount corresponding to the elevation correction. Where water area exists, or is proposed, a second correction for water area was made. The results so reached were accepted as the most probable mean run-off values for the areas under consideration.

It is not to be expected that any high degree of precision can be reached by this simple procedure. The run-off data are too few, and too many unknown elements are left out of account. It is thought, however, that one important element has been taken into account in a rough way, and that the result reached may be more accurate because this has been done.

The amount of water that may be safely counted on in dry years with various amounts of storage may be computed by the methods described in the Transactions of the American Society of Civil Engineers, Vol. 77, p. 1539. For these estimates the mean flow is always the starting point, and the subsequent calculations thus rest on estimates in which the elevation of the catchment area is an element.

War-Built Turbine Ships Inferior

In testimony before the Congressional committees considering the ship subsidy bill E. E. O'Donnell, of C. H. Sprague & Co., Boston, operating in the coastwise coal trade, testified that turbine engines in ships built during the war are not as good as those constructed in normal times. "In building the turbine engines during the war the materials did not go into the engine that would ordinarily go in normal times, in the way of steel, copper, etc., due to the great demand of the military organization for copper, brass and steel," he said. "These turbine ships will not stand up as well as the average vessel built prior thereto or at the present time. Eighty per cent of the government's fleet was built with these turbine engines. I consider the reciprocating engine and the Scotch boilers as better, although not so considered by engineers. They are the most dependable."

Mr. O'Donnell said the average seaman is prejudiced against the water-tube boiler in merchant ships as the boiler requires a great deal of attention. It requires a tight condenser or there will be trouble with the tubes in the boiler from salt water getting into the boiler causing incrustation and burning out. As to oil-burning ships, he said it was an engineering question, which might be argued both ways, whether there are less boiler repairs on an oil vessel than on a coal burning vessel; the oil vessel has a more constant steam pressure and uniform temperature throughout the boiler.

Alkali Attack on Concrete Roads and Building Brick

Notes on the Study of Disintegration in the Rice Field Country of Glenn County in California

By Irving Furlong
Associate Chemist, Bureau of Standards, Appraisers Building, San Francisco, Cal.

GLENN COUNTY, California, is situated in that part of the upper Sacramento Valley bounded on the west by the Coast Range and on the east by the Sacramento River. The general trend of drainage is to the southeast. In parts of the county, drainage is practically absent. Owing to deposits of alkali in the Coast Range, water with its source in the mountains reaches

FIG. 1. FLOODED CONCRETE HIGHWAY IN RICE FIELDS

the valley bearing dissolved alkali, and those parts of the county lacking natural drainage have long been the reservoirs for alkali-bearing water. All water in this district is alkali bearing. Wherever water has evaporated, alkali crusts are residual.

During the winter months, parts of Glenn County are inundated (Fig. 1). Because of the general alkaline condition of the soil and the excessive water, the alkali district was neglected agriculturally previous to the successful experiments with rice. By diking up the fields in checks in such a way that ponds 6 to 8 in. deep could be formed, the natural conditions prevailing produced ideal rice production territory. The California Highway traverses the rice field section of the Glenn County alkali district, the rice fields bordering the highway right-of-way for many miles. The salient point here is that the level of the water in the rice ponds is in places higher than the crown of the highway. In such places, the highway subgrade is water-saturated and wherever broken concrete permits, surface exposure of alkali water on the highway is in evidence. That part of the highway traversing the rice fields has suffered nearly a complete breakdown and brick buildings located in the heart of the alkali district show evidences of incipient disintegration. The views show some of this damage.

The Bureau of Public Roads has made a detailed study of the Glenn County alkali district. Highway condition was correlated with extent of alkali deposits in contact. The evidence evolved appears conclusive

that where seepage into depressions has been the heaviest, there the alkali deposits are the most abundant and the degree of highway disintegration is a function of the amount of alkali in contact.

In experiments with test specimens representing aggregate identical with that employed in the building of the Glenn County Highway Route, the testing laboratory of the California Highway Commission reproduced the deleterious effects of the Glenn County alkali on such aggregates. In the range studied, the leaner mixes, when subjected to alternate wetting and drying in alkali water, yielded to the alkali attack more rapidly and completely than the richer mixes. Under no conditions of experimentation with unprotected concrete was entire immunity to alkali water established.

The above mentioned evidence leaves practically no doubts that alkali played an important role in the disintegration of several miles of the Glenn County Highway. Heavy truck traffic passing over a concrete slab laid over a water saturated subgrade probably hastened the disintegration, but the same conditions now observed would have ultimately obtained even if there had been no traffic of any sort on the highway. Fig. 4 shows a portion of a concrete bridge in the affected area of Glenn County. Alkali water, unassisted by the wear and weight of truck traffic has rendered the concrete in this bridge friable to such an extent that it is gradually crumbling away. [An article in *Engineer-News-Record*, Feb. 3, 1921, p. 217, shows a concrete road design intended to remove the alkali water from contact with the concrete.]

Composition of Alkali—Regarded as a unit grouping, the alkali concentration varies from a fraction of one per cent up to practically the pure crystals. The principal alkali found throughout the district is sodium sulphate though in some places the concentration of magnesium sulphate reaches proportions worth consideration. For the most part, the sulphates and chlorides of calcium and magnesium and the carbonate and chloride of sodium are represented in such minor proportions as to make them appear as only contaminations to the sodium sulphate. Fig. 7 represents analyses of alkali extracted from typical Glenn County soils according to the plotting system described in Bureau of Standards Technologic Paper 95.

Whatever harm attributed to alkali that has been done to the highway or brick buildings in the affected region must be due to a large extent to the water-soluble sulphates.

Drainage of Alkali—In a system of mixed salts such as the Glenn County alkali represents, it was expected that the physical-chemical laws governing the deposition of crystals from aqueous solution could be demonstrated. Calcium sulphate was the least soluble salt represented and was therefore found most abundantly in other than the surface accumulations, being the first crystals to drop from solution as concentration due to surface evaporation proceeded. Sodium sulphate, being less soluble than magnesium sulphate or sodium chloride, crystallized out along pond and ditch banks, leaving the water relatively richer in respect to magnesium sulphate and sodium chloride. So long as there was any water present, most of the magnesium sulphate and sodium chloride remained in solution. Whatever natural drainage there was to the district, therefore, should carry away magnesium sulphate and sodium

FIG. 2. SURFACE ALKALI ALONG A ROAD

chloride in solution and if the dilution of that drainage water was sufficient, then also should a general leaching of the sodium sulphate from the district be effected.

The natural drainage of the district trends towards the southeast. A sample of alkali taken in the path of natural drainage several miles from the heart of the Glenn County trouble zone is represented in Plot 5. In this the magnesium sulphate and sodium chloride predominate. This sample was taken in June when the normal temperature is over 100 deg. F., and when drainage is probably at the lowest ebb. Comparing Plots 4 and 6 which represent normal alkali composition in the Glenn District with Plot 5 representing alkali withdrawn by drainage, it would appear that there is a movement of sodium chloride and magnesium sulphate out of the district, even during the summer months.

It may be interesting to note that where a lateral concrete highway traverses the drainage path from the Glenn District, there also is concrete disintegration in evidence.

Brick Disintegration—In the heart of the Glenn County alkali district are two brick buildings, the Norman warehouse and the post office building. Both buildings show evidences of incipient disintegration, the Norman warehouse to the greater extent. Fig. 5 shows a portion of the affected area of the Norman warehouse and Fig. 6 is a detail of the wall of the Post Office building.

In attempting to retard the first phase of the disin-

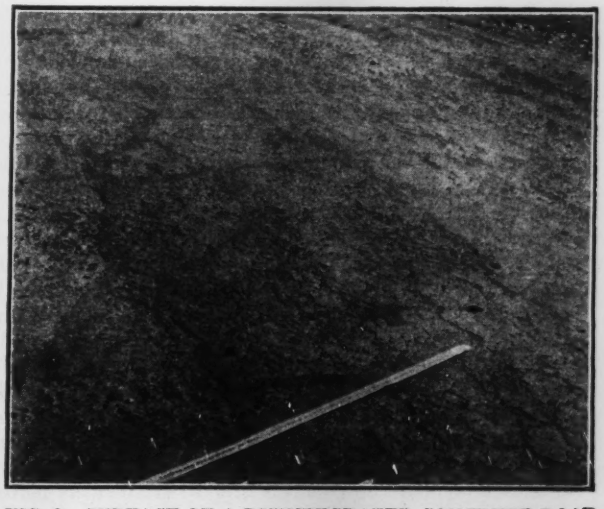


FIG. 3. SURFACE OF A DISINTEGRATED CONCRETE ROAD

tegration, which was manifested in the gradual crumbling away of the mortar between bricks, a cement plaster was applied over the affected area of the Norman warehouse. At present writing, the disintegration has extended at a fairly uniform rate above the plaster all along the wall. In places, the cement plaster shows some signs of disintegration, not only checking but a tendency to peel or slab away from the wall. Most of the bricks in the affected area are more or less covered with a fine frost-like white crystaline powder. Many of these bricks have rounded corners and show tendencies to scale, powder and crumble. The wall above the present affected area is in normal condition, the mortar is in fair state and the bricks are sharp edged.

While the immediate cause for brick disintegration in the Norman warehouse can unquestionably be attributed to alkali attack, it was thought worth while to determine if possible the relation of quality of brick to

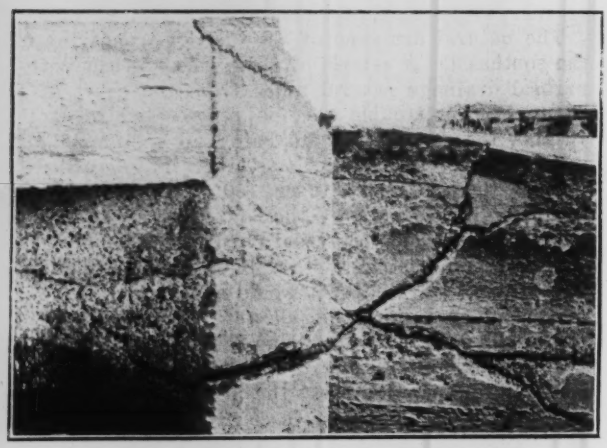


FIG. 4. CONCRETE ABUTMENT GOING TO PIECES
Disintegration doubtless due to soil effect of alkali water.

susceptibility to alkali attack. The bricks used in the Norman warehouse represent local manufacture from a local raw material consisting of a natural mixture of about one part clay to three parts of sand. The alkali content of the average material from the so-called clay beds was about 1 per cent. As plot 1 shows, sodium sulphate predominates. Surface samples taken at the clay beds yielded about 14 per cent alkali. The details of the alkali composition are shown in Plot 3. With exception of the apparent surface accumulation of magnesium salts, the average clay differed but little from the surface clay in respect to nature of alkali included. The principal difference was quantitative only. Plot 2 shows the composition of the water-soluble alkali now present in the bricks in the alkali affected area in the Norman warehouse. Plot 2 is directly comparable with Plots 1 and 3 since it represents water-soluble alkali content in the bricks as compared with the water-soluble alkali content of the parent material.

The increase in calcium salt in the brick is probably attributable to a small admixture of lime mortar, an adherence to the bricks in sampling. The outstanding difference and conspicuously new phase found in the brick but not in the parent clay was water-soluble silica. The first impression here might be that a case had been found with chemical proof to support the theory that the attack of alkali on concrete and other siliceous materials is one of chemical replacement such as

$$CaSiO_3 + Na_2SO_4 = CaSO_4 + Na_2SiO_3$$

Such a reaction would convert a water-insoluble silicate into a water-soluble silicate. However, other facts in the case do not bear out the idea that such a reaction is taking place in the Norman warehouse bricks. If the concentration of alkali present, over a long period of years, could effect such a transformation in semi-vitreous brick, then the same concentration of alkali could and would with far greater rapidity attack all of the silicates in the entire alkali district. However, water-soluble silica was found in the bricks only. It is not therefore thought that the soluble silica in the bricks is not due to any prolonged attack of alkali on silicate but that it is a product of reaction during the burning of the brick. Fusing alkali with water-insoluble silicate will always produce some water-soluble silicate. Hence, the soluble silica now present in the Norman warehouse brick was probably there when the bricks were laid, a result of the temperatures of manufacture.

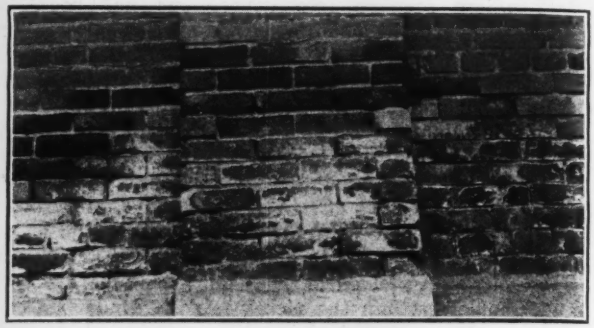


FIG. 5. PART OF ALKALI-AFFECTED BRICK WALL ON WAREHOUSE

A close study of Photo 5 will reveal that a few of the bricks in the affected area have apparently been immune to disintegration in any form. A field study of such bricks indicates that they had been more thoroughly burned than the adjacent bricks suffering

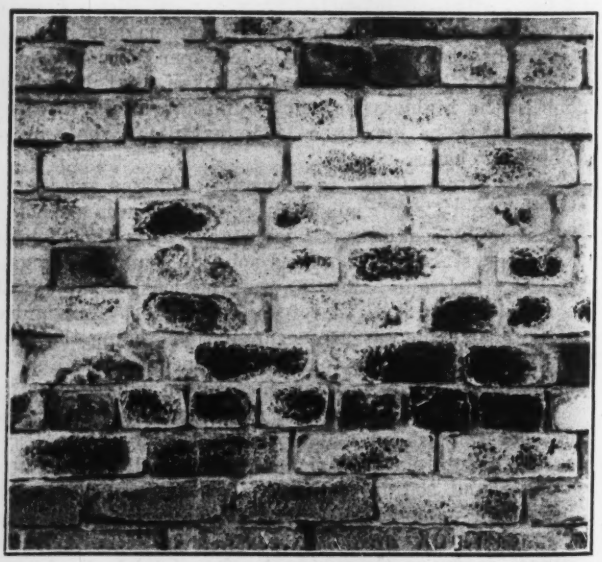


FIG. 6. BRICK WALL OF POST OFFICE BUILDING

disintegration. More thorough burning brought about a sealed condition in respect to percolating waters. No chance was left for solution and removal of any constituent in such a brick nor could percolating waters carry alkali in to function later as a splitting agent.

It has been demonstrated many times that the porous concretes give way to alkali attack much faster than the dense non-porous mixes. It seems demonstrated here that this applies also to bricks. The well burned sealed bricks are standing up, the under-burned porous bricks are giving way under alkali attack.

To whatever cause may be assigned the splitting action of percolating alkali water in concrete, the same action appears to affect brick, though possibly at a slower rate. The Norman warehouse is gradually giving way to the same agencies, principally sodium sulphate, that have already fatally attacked the concrete highway near by.

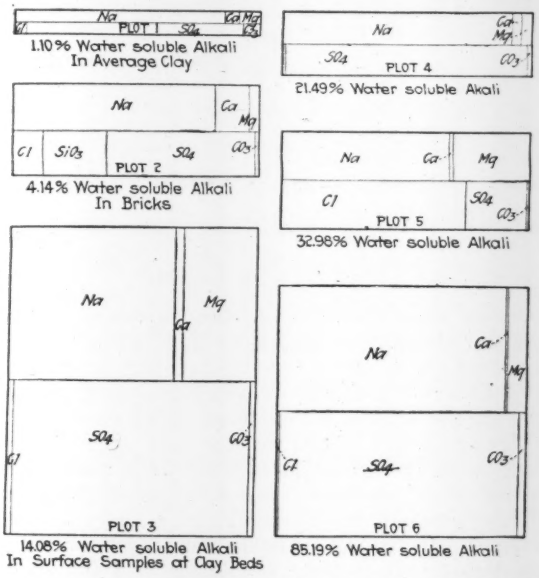


FIG. 7. PLOTS OF VARIOUS SOILS AND WATERS BEARING ALKALI IN GLENN CO., CALIFORNIA

In spite of the alkali content, the local clay could have been burned into a good sound brick had the burning been properly carried out. Even under-burned brick would have yielded long satisfactory service if not used in contact with alkali water.

British Tidal Power Scheme Held Up

The proposed utilization of tidal power on the Severn River in England, for which a number of studies were made by the British government, is apparently not progressing. According to *The Engineer* the Water Power Resources Committee has considered the subject of tidal power, and expressed the view that the technical information available in regard to the possibility of utilizing the tides in the Severn for the generation of power was not sufficiently precise to enable it to express a final opinion. The committee recommended that a technical commission should be set up by the Board of Trade, in consultation with the Ministry of Transport, to investigate the possibility from a commercial standpoint with special reference to the Severn Estuary. The proposed commission has not, however, been set up.

Hydraulics of Dosing Tanks and Trickling Filters

How to Design So That Settled Sewage Will Be Delivered Intermittently at Uniform Rate Per Square Foot

BY E. E. SANDS
Consulting Engineer, Houston, Tex.

THE designer of a trickling filter endeavors to plan a plant that will deliver the settled sewage intermittently onto the surface of the filter at a uniform rate per square foot. The usual design involves a dosing tank, a system of distributing pipes and spraying nozzles. When the plant is of large magnitude it may be necessary to slope the surface of the filter or vary the spacing of the nozzles in order to get as high a rate per square foot on the areas remote from the dosing tank as is used on the area nearest to the dosing tank. This discussion will be confined to the application of sewage to a level bed of moderate area, the settled sewage being applied by a dosing tank controlled by an automatic siphon, a system of distributing pipes and the usual commercial nozzles.

Generally Accepted Conclusions—At the outset attention is invited to the conclusions that have already been brought to the attention of the profession by various investigators and to certain facts that are apparent to all persons who have designed and operated sewage-works: (1) No designer for a municipality knows anything about the quantity of sewage the plant will be required to handle before it is replaced by a larger one. (2) Anticipated results from the use of refinement in the hydraulic calculation are apt to be nullified by careless operation and other conditions beyond the control of the designer. (3) Ideal conditions seldom exist and even if the system would give absolutely uniform distribution in a laboratory test these conditions would be upset by the wind blowing across the filter. (4) Experimental work has shown that a dosing tank shaped like an inverted pyramid gives a nearer approach to uniform distribution than any other easily constructed form. (See "Aërial Distribution of Sewage Over Percolating Filters," by William Gavin Taylor, *Engineering News*, Nov. 11, 1909, p. 511.) (5) The area served by a nozzle under the maximum head is directly proportional to the head. In other words, the spacing of the nozzle will vary as the square root of the maximum head. (6) The discharge of a nozzle at any head will vary directly as the area of the orifice of the nozzle dome and as the square root of the head. (7) The automatic siphon usually employed consumes head which varies as the square of the quantity discharged. In other words, the discharge follows the law of an orifice and $Q = k\sqrt{h}$.

From (5) and (6) it follows that using nozzles with the same area of orifice and the same cycle of application, we increase the rate of sewage applied per square foot or per acre by reducing the maximum head and the spacing of the nozzles. The same result may be accomplished by increasing the area of the orifice of the nozzles but there are practical limits to this procedure.

Hydraulic Theorem—Before proceeding further it is necessary to demonstrate an elementary theorem in

hydraulics. Quite probably it may be found in various textbooks but the writer has never seen it. If several units of hydraulic apparatus form a system which delivers water under pressure and each unit or part of the system is governed by the law $Q = k\sqrt{h}$, where h is the lost head or fall in hydraulic gradient for the unit, then the discharge of the whole system is $Q = K\sqrt{H}$, where K is a new constant and $H = \Sigma h$ and any ratio $\frac{H}{h}$ remains constant.

FIG. 1

$$Q = k_1\sqrt{h_1} = k_2\sqrt{h_2} = k_3\sqrt{h_3} = \ldots\ldots = k_n\sqrt{h_n}$$

$$Q^2 = k_1^2h_1 = k_2^2h_2 = k_3^2h_3 = \ldots\ldots k_n^2h_n.$$

$$\frac{Q^2}{k_1^2k_2^2k_3^2\ldots k_n^2} = \frac{h_1}{k_2^2k_3^2\ldots k_n^2} = \frac{h_2}{k_1^2k_3^2\ldots k_n^2} =$$

$$\frac{h_3}{k_1^2k_2^2k_4^2\ldots k_n} = \frac{h_n}{k_1^2k_2^2k_3^2\ldots k_n^2}$$

$$\text{Let } K = \sqrt{\frac{k_1^2k_2^2k_3^2\ldots k_n^2}{(k_2^2k_3^2\ldots k_n^2) + (k_1^2k_3^2\ldots k_n^2) + (k_1^2k_2^2k_4^2\ldots k_n^2) + ()\ldots() + (k_1^2k_2^2k_3^2\ldots k_{n-1}^2)}}$$

Let $H = \Sigma h$. Then $Q^2 = K^2H$ and $Q = K\sqrt{H}$.

Fortunately the value of K never has to be solved by the use of the formula.

Design of Dosing Tank and Distributing System—With this preliminary work let us now consider the design of a dosing tank and the distributing system of a trickling filter. The problems that confront the designer are: Nozzle spacing; size of distributing pipes; time required to empty the tank; the time required to fill the tank.

Since it is proposed to use a hopper of an inverted pyramid for our tank (*ABCD*, Fig. 2) let us place the apex of the pyramid (O) at the same elevation as the nozzle orifices (E). The advantage of this practice will soon be apparent. An investigation will now be made of the time required to empty such a dosing tank.

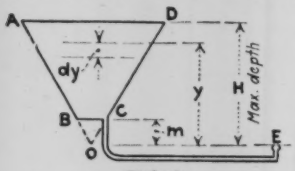


FIG. 2

To avoid confusion we will let y = the elevation of the water surface above the orifice or dome of the nozzles, and by geometry the area of the water surface = by, where b is a constant depending upon the side slopes of the tank. Let T = seconds required to empty tank with a constant inflow of R sec.-ft. and T_1 = seconds to empty tank with $R = 0$. Let all dimensions be in feet, quantities in second-feet and time in seconds.

The discharge is influenced by friction heads in the siphon located at C; in the pipe leading from C to E, and at the nozzle E. The discharge of each of these appurtenances is approximately as follows: Siphon = $K_1\sqrt{y_1}$ (includes velocity and entrance heads); pipe = $K_2\sqrt{y_2}$; nozzle = $K_3\sqrt{y_3}$; combined = $K\sqrt{y}$. The area of the water surface at any elevation $y = by^2$ where b is a constant.

Now as the tank is being emptied there will be an inflow of R sec.-ft. Then the net rate of reduction in the contents of the tank for any head y will be $Q = K\sqrt{y} - R$. dQ for any time $dt = by^2dy = dt(K\sqrt{y} - R)$. $dt = \frac{by^2dy}{K\sqrt{y} - R}$.

For convenience let $Kn = R$ and $n = \frac{R}{K}$; let $z = \sqrt{y}$. Then $dt = \frac{b}{K}\left(\frac{y^2}{\sqrt{y} - n}\right)dy = \frac{2b}{K}\left(\frac{z^4}{z - n}\right)z\,dz = \frac{2b}{K}\left(\frac{z^5}{z - n}\right)dz$.

$$dt = \frac{2b}{K}\left(z^4 + z^3n + z^2n^2 + zn^3 + n^4 + n^5\frac{1}{z - n}\right)dz$$

$$T = \frac{2b}{K}\frac{\sqrt{H}}{\sqrt{m}}\left[\left(\frac{z^5}{5} + \frac{nz^4}{4} + \frac{n^2z^3}{3} + \frac{n^3z^2}{2} + n^4z + n^5\log_e(z - n)\right)\right]$$

$$T = \frac{2b}{K}\frac{H}{m}\left[\left(\frac{y^{\frac{5}{2}}}{5} + \frac{ny^2}{4} + \frac{n^2y^{\frac{3}{2}}}{3} + \frac{n^3y}{2} + n^4y^{\frac{1}{2}} + n^5 2.3026\log_{10}(\sqrt{y} - n)\right)\right]$$

Let $R = O$. Then $n = o$ and $T_1 = \frac{2b}{5K}\Big/_{m}^{H} y^{\frac{5}{2}}$ = time to empty tank down to m with no inflow.

Design of a Small Plant—Let us design a dosing tank and distribution system to apply 0.5 m.g.d. a day to a filter bed at the rate of 2½ m.g. per acre per day. For southern conditions we will place the distributing pipes on the surface of the filter, using no risers. As the sewage is well settled we will use comparatively low velocities in the distributing pipes, thus reducing pipe friction to a minimum. Clean-out or blow-off plugs will be provided at the ends of each pipe lateral. Assume: Maximum available head (H), water surface dosing tank to dome of nozzles = 7 ft. Average flow = 350 g.p.m. = 0.78 sec.-ft. Maximum flow = 500 g.p.m. = 1.11 sec.-ft. Use Taylor square nozzles. Area filter bed = ⅕ acre = 8,710 sq.ft. With a total head of 7 ft. it is probable there will be 6 ft. available for nozzles. (The head available for the nozzles will usually be from 80 to 90 per cent of the total.) Space nozzles 12 ft. apart. (See curves furnished by manufacturer.) Area served by nozzle = 144 sq.ft. Number nozzles required = 60. Make bed 6 x 10 nozzles = 72 x 120 ft.

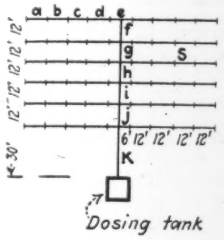
For preliminary design let us assume a maximum discharge = 3 times maximum rate of sewage inflow = 1,500 g.p.m. = 3.34 sec.-ft. Then the maximum rate of flow for each nozzle = 25 gal. per min. Select a size orifice to give, as nearly as possible, a discharge of 25 g.p.m. under a 6-ft. head. A Taylor square nozzle with a $\frac{7}{8}$-in. orifice and a $\frac{3}{8}$-in. spindle discharges 23 g.p.m. under a head of 6 ft. Try a design using 60 of these nozzles. Then the maximum discharge = 23 × 60 = 1,380 g.p.m. = 3.08 second-feet.

The accompanying diagram (Fig. 3) and table give the maximum discharges for the various pipe elements, together with velocities and friction losses.

Next try a 12-in. Miller siphon. Head for 1,380 g.p.m. = 4.93 in. = 0.41 ft. (P. 63, Catalogue 14) Pacific Flush Tank Co. Select nozzle S as representing average conditions and compute lost heads for maximum flow:

	Loss of Head, Ft.
Nozzle	= 6.00
12 ft. pipe @ 5½ ft. per 1,000 ft.	= 0.07
12 ft. pipe @ 9.0 ft " "	= 0.11
6 ft. pipe @ 2.0 ft " "	= 0.01
Entrance and vel. head (vel. + 1.4 ft.)	= 0.05
12 ft. pipe @ 1.7 ft. per 1,000 ft.	= 0.02
12 ft. pipe @ 2.8 ft. per 1,000 ft.	= 0.03
12 ft. pipe @ 4.0 ft. per 1,000 ft.	= 0.05
30 ft. pipe @ 6.0 ft per 1,000 ft.	= 0.18
Loss in siphon	= 0.41
Total	6.93, say 7 ft.

The formula for the discharge of this system will now be computed. 1,380 g.p.m. = 3.08 sec.-ft. Then $3.08 = K\sqrt{7}$, and $K = 1.163$. The discharge in second-feet for any head $y = 1.163\sqrt{y}$. Determine the elevation of the bottom of the bell of the siphon. The maximum rate of inflow into dosing tank = 500 g.p.m. We should allow a factor of safety of at least 50 per



PIPE	MAX. Q, G.P.M.	SIZE PIPE INCHES	VEL., FT.	FRICTION LOSS IN FT. PER 1000 FT.
a	23	3	1.1	3½
b	46	3	2.1	10½
c	69	4	1.8	5½
d	92	4	2.4	9.0
e	115	6	1.4	2.0
f	230	8	1.5	1.6
g	460	10	1.9	2.0
h	690	12	2.0	1.7
i	920	12	2.6	2.8
J	1150	12	3.3	4.0
K	1380	12	4.0	6.0

FIG. 3. PIPE SYSTEM FOR TRICKLING FILTERS

cent on this item, so we will assume inflow into dosing tank = 750 g.p.m. = 1.67 sec.-ft. $1.67 = 1.163\sqrt{y}$. $\sqrt{y} = 1.436$. $y = 2.06$ ft. Let $m = 2$ ft. $Q = 1.163\sqrt{2} = 1.646$ sec.-ft. = 739 g.p.m.

Place the bell of siphon 2 ft. above the nozzle orifices and it will sniff with any probable rate of inflow and continuous operation will be avoided.

The next step is to design the dosing tank. The time required to empty can be approximated quite closely without the use of the formula. If we compute the rates of discharge for the maximum and minimum heads and average them we get what may be called the average rate of discharge. The true mean discharge will be from 8 to 16 per cent above this average. For preliminary design we may assume that the mean rate of discharge is 110 per cent of the average rate.

For the tank we are considering the various rates of discharge in second-feet are: Maximum, 3.08 $(1.163\sqrt{7})$. Minimum, 1.65 $(1.163\sqrt{2})$. Average, 2.365. Mean, about 2.60 sec.-ft. Then the net rate of emptying the tank for an inflow of: 500 g.p.m. = 2.60 — 1.11 = 1.49 sec.-ft. and for 350 g.p.m. = 2.60 — 0.78 = 1.82 sec.-ft.

We will now try various sizes of tanks and see about what sort of dosing cycles will result. Try a tank that holds 200 cu.ft. Then for maximum inflow at 500 g.p.m. we would dose 134 sec. = 2 min. 14 sec. and rest 180 sec. = 3 min. 0 sec. For 350 g.p.m. flow we would dose 110 sec. = 1 min. 50 sec. and rest 257 sec. = 4 min. 17 sec.

A few years ago a cycle of 3 minutes' dosing time and 7 minutes' rest was considered good practice. At present the tendency is toward a very short period of rest. All that is necessary to vary the cycle is to increase or reduce the size of the tank.

Suppose that the above cycle is satisfactory to the designer. Then the tank must be a 5-ft. frustrum of a 7-ft. pyramid and hold 200 cu.ft. This is solved by elementary geometry and the area of the maximum water surface (base of pyramid) = 87 sq.ft.—say 8⅞ x 10 ft.

We now have completed the design by approximate methods, the next step is to investigate the design by using the formula. We have all the constants: Maximum water surface $= 87 = b\,y = b\,7^2 = 49\,b$. $b = 1.77$. $K = 1.163$. $H = 7.0$. $m = 2.0$. $n = \frac{R}{K} = \frac{1.11}{1.163} = 0.954$ for 500 g.p.m. inflow; and $\frac{.78}{1.163} = 0.671$ for 350 g.p.m. inflow.

Applying the formula we find the actual time to empty tank for inflow of 500 g.p.m. (= 1.11 sec.-ft.) = 135 sec. = 2 min. 15 sec.; 350 g.p.m. (= 0.78 sec.-ft.) = 109 sec. = 1 min. 49 sec.

It is realized that the method here presented is subject to criticism. For instance, the exponent in the formula for the discharge of a cast-iron pipe is nearer ⅔ than it is to ½. The coefficients do not remain constant under variable heads, but the error resulting from the use of the formula will be small and it is believed that the method outlined is sufficiently accurate for all practical purposes.

For Consolidation of Society Effort

Extract from Paper by Adolph F. Meyer, President, Minnesota Federation of Architectural and Engineering Societies, Presented to the Federation at Its Recent Meeting.

WE engineers and architects have really been "penny wise and pound foolish" in the management of our own affairs. A similar policy pursued in our professional work would have been ruinous. We have split up into societies and sections that promise to outnumber even the branches of the Christian church. Highly specialized technical problems may advantageously be discussed by small professional groups, but these groups should leave to single community organizations those matters that affect the relation of our profession to that community, and such organizations should in turn act on matters of state-wide interest through this federation.

Civic problems can advantageously be handled through the committees of civic bodies on which our profession should have better representation. We should establish contact between our technical societies and civic bodies through the medium of those of our members who are appointed on the committees of these bodies so that these men might express the judgment of entire professional organizations rather than merely their own.

As the result of endless subdivision of the profession, technical meetings have multiplied in number until they have become burdensome and interest has flagged. Men's activities have been divided until the fractions thereof have become almost invisible and quite ineffective. A single monthly meeting in each large city, always at the same place and date, featuring a variety of subjects of general interest and dealing with all branches of the profession, each well-attended, would conserve our time and effort, tend to consolidate our interests and do more to further our professional standing than the present multiplicity of group gatherings.

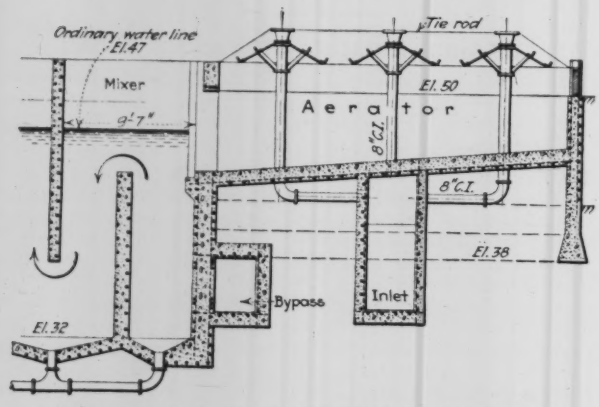
A similar criticism might well be directed at publications. Every organization, every industry and every branch thereof is publishing some form of "official paper." Most of these publications are forced to live on their advertising income. Advertising in such minor publications seldom reaches new prospective buyers and is usually in essence a donation prompted by friendship. As such it cannot justify its existence.

Aerators and Copper Sulphate for Tastes and Odors

Six-Years' Experience with Impounded Supply Leads to Use of Fountain Aerators to Augment Action of Copper Sulphate

IMPROVEMENTS made recently to the water-treatment plant at Danville, Ill., include six fountain aerators of novel design to assist copper sulphate in eliminating tastes and odors. The aerated water will pass through a new up-and-down baffled mixing chamber and a large new settling basin.

Danville's water supply is impounded by two dams on the north fork of the Vermillion River, one in service since 1903 of 75-m.g. capacity at the pumping station and the second, completed in 1915, of 450-m.g. capacity four miles upstream. H. M. Ely, superintendent of the Interstate Water Co., which owns the Danville water-works, at the recent meeting of the Illinois section of the American Water Works Association, noted in a round-table discussion his experience with algae growths since 1916 and outlined the improvements which were designed by Mead & Seastone, consulting engineers, Madison, Wis. These additions were completed in August, 1921. The following notes are taken from Mr. Ely's remarks and some further information supplied by him:

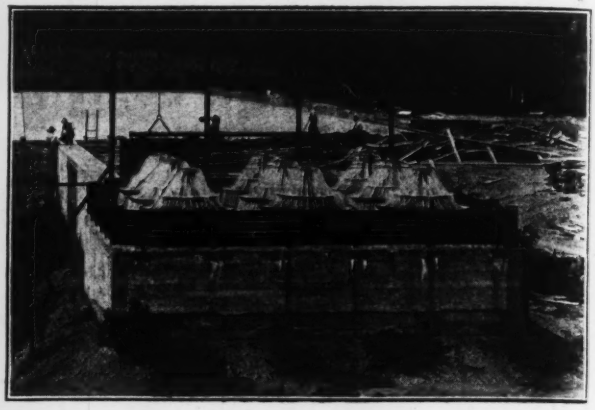


PERFORATED CONICAL TRIPLE-FALL AERATORS

Algae existed in the lower reservoir for some years but previous to 1916 were never of such character or amount as to cause trouble. In September, 1916, microscopical examinations of water from each reservoir made by the State Water Survey showed moderate algae growths. The microorganisms found were protozoa, rotifers, chlorophyceae, crustacea rather numerous, protococcus most numerous and euglena in small numbers. In July, 1917, the organisms present were diatoms, protococcus, rotifers, crustacea and the algae forms but no euglena.

Drought and Odors—From July 1 to the latter part of October, 1919, Danville experienced a severe drought, following a deficient rainfall in all the preceding months of the year. The lower reservoir was drawn down 5 ft. but maintained at that level by allowing water to flow from the upper reservoir through a gate in the dam downstream into the lower reservoir. In doing this the upper reservoir was drawn down 9 ft.

On Aug. 18 obnoxious tastes and odors suddenly appeared rendering the water unpalatable. Bacterially the water was safe for drinking purposes. Inspection of the reservoirs on Aug. 20 and 21 showed patches of green scum and



TRIPLE-FALL FOUNTAIN AERATORS IN ACTION

Gallows frame supports stop-log gate controlling mixing chamber directly in the rear. Part of new settling chamber further back.

in places streaks of brick-red colored scum were noted. The effect seemed to be distributed throughout the reservoir, for even where no scum existed on the surface, the water had a reddish cast. The scum area was much smaller than in previous years and was composed of different forms of micro-organisms. On Aug. 26 the State Water Survey found that each reservoir contained euglena, which was dominant, uroglena, peridinium, anabaena, arcella, diatoms and rotifers. The first three organisms are known to impart a fishy and oily taste to the water and the fourth a greasy or moldy taste.

Copper Sulphate Used—On Aug. 27 the lower reservoir was treated with copper sulphate. As nearly as could be determined, 1½ lb. p.m.g. or 0.2 p.p.m. were used. This had no effect upon the taste and odor. From Oct. 2 to 9 the water flow from the upper reservoir was treated with copper sulphate at the rate of 5 lb. p.m.g. The lower reservoir was again treated, but at a rate of 8 lb. p.m.g. About Oct. 7 the taste and odor began to disappear and in a few days the character of the water was back to normal. On Oct. 5 and also on Oct. 9 a heavy rainfall occurred, which may have been a factor in bringing about the improvement.

An unusually severe drought occurred in 1920, from June to December. The lower reservoir was drawn 11 ft. and the upper reservoir 16 ft. During this period there was a slight odor at times, but not enough to cause annoyance. No microscopical examinations were made.

In 1921 the water company bought a microscope and began to make frequent examinations in order to anticipate any possible trouble by gaining a knowledge of the condition of the water and by beginning the copper-sulphate treatment early. The organisms found during that summer were volvox, protococcus, pediastrum and scenedesmus, all of the chlorophyceae group; peridinium of the protozoa group, and anabaena of the cyanophyceae group. Volvox and peridinium impart a fishy taste, anabaena a moldy taste. The other organisms are not troublesome. While the fishy odors were eliminated, the moldy odor was not altogether dissipated by copper-sulphate treatment nor by aeration after it was started in August, 1921. The moldy odor lasted several weeks, and while rather disagreeable was not nearly so serious as the odor in 1919.

The aerator was built to remove the taste and odor from the water. It consists of a group of fountains set 8 ft. c. to c. in a concrete basin which is 25 ft. square in plan inside at the top and has a bottom that slopes toward the mixing chamber, giving an ordinary water depth of from 1 to 3 ft. The fountains consist of vertical pipes, near the top of which are placed perforated boiler-plate conical hoods, 6 ft. in diameter. Perforated circular baffles on the hoods at the center line and bottom still further break up the flow. The water falls from the top of these pipes down over the hoods and through the perforations. The minimum fall from the rim of the hoods to the ordinary water level

is 5 ft. The fountains are anchored in place by ⅜-in. tie rods. The concrete basin walls are surmounted by louvres to permit a free circulation of air.

As the aerator was not completed until August, 1921, there has not yet been an opportunity to make a thorough test as to its removal of tastes and odors. While the experience has not yet been sufficiently broad to state just what can be accomplished by the combination of copper sulphate and aeration, it is believed that a material improvement can be made in the character of the water when such tastes and odors occur.

Models in Civil Engineering Instruction

By J. T. Thompson
Associate Professor, Civil Engineering Department, Johns Hopkins University, Baltimore

IT IS a common experience that the appeal to the mind through the senses of sight and touch is much stronger than that through the sense of hearing. The instructor in civil engineering may therefore at times be at a disadvantage when compared with the instructor in electrical or mechanical engineering. The latter is usually able to show his students the motor-generator set or the turbine he is discussing for the reason that practically every technical school has such equipment, but what can the instructor in civil engineering do about the dam or bridge that he wishes to discuss? True, he can show his students a photograph of it, can describe it in detail, can even make blackboard sketches of it; but with all this his colleague in the other department has some advantage. For, not only can he do all this but in addition his students can handle the full-sized apparatus, run it, play with it, and leave it with a far stronger mental picture and more intimate knowledge than if they had merely seen a picture or a blackboard sketch of it or had merely listened to a description of it.

It is, of course, rarely possible for a civil engineering department to have a couple of bridges on the campus for class demonstration, but there is much that can be done along substitute lines. Inspection trips to local structures, which are undoubtedly of great value, are not always possible or convenient and so we face the necessity of providing other means of instruction. Why not by the more intensive use of practical models? The paragraphs which follow describe, as an example, a model in use in the civil engineering department of the Johns Hopkins University, and tell how it is used and with what success its use has met.

Plate-Girder Bridge Model—The accompanying photographs depict a model of a through plate-girder bridge of 100 ft. span. The model is 52 in. long and has a web 4 in. deep, the scale being 1 in. to 2 ft. It is made entirely of brass; the angles were milled from square brass stock. In place of rivets, the parts are connected throughout with No. 6 32-thread machine screws with hexagon nuts. The rivet pitch in all flange angles is ½ in., no attempt having been made to represent the true pitch.

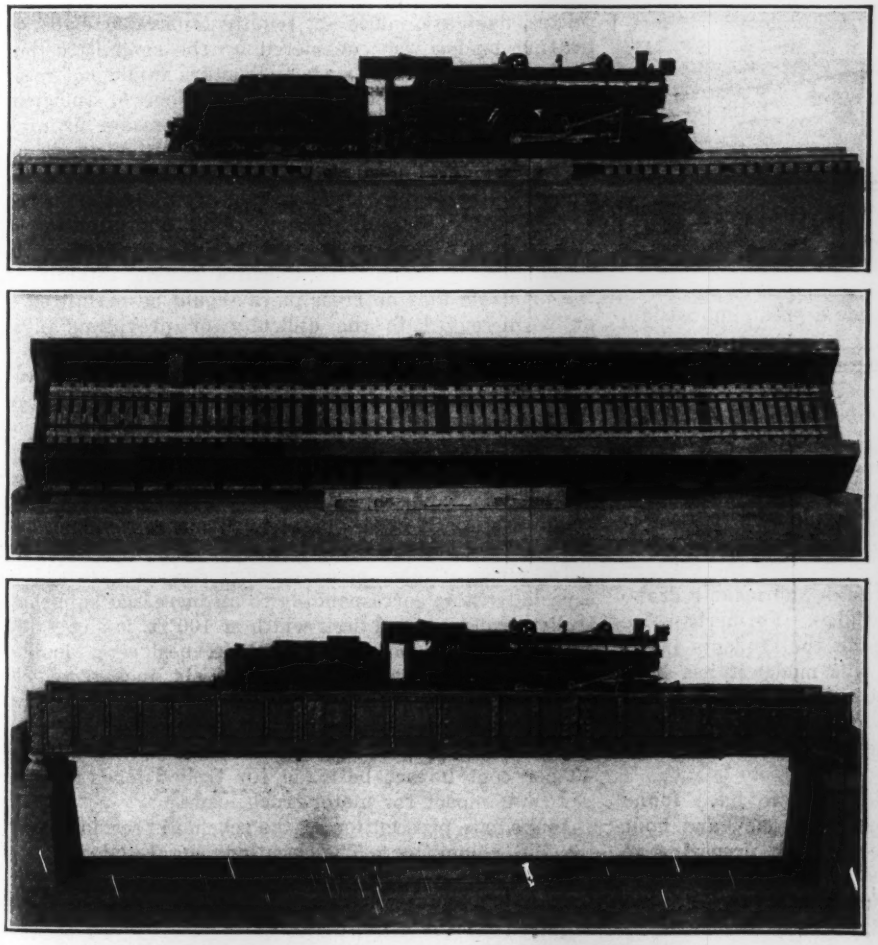


FIG. 1. LOCOMOTIVE AND BRIDGE MODELS

Used in connection with a model locomotive, the model conveys instantly to the student's mind how the load is carried to the main girders and impresses him once and for all with a fact that is often hard for him to see otherwise—that the live load can come into the main girders only at the panel points.

Web-Action Shown—One of the most useful and interesting points brought out by this model is shown in Fig. 2, which demonstrates the action of the web under stress. Here the brass web has been removed from one of the girders and a heavy paper web substituted for it. Loads applied at the third-points under two different conditions are shown in the cut. The effect of diagonal compression due to shear is clearly demonstrated by the long buckles which appear in the web between the loads and the supports. From the upper view it is apparent that this buckling of the web is due to shear, since between the loads, where the shear is zero, no buckles appear. The buckling of the web involves the column action of a strip of web in-

clined to the horizontal, roughly at right angles to the buckles.

The middle view in Fig. 2 shows the girder with stiffeners applied between one of the loads and a support. It is obvious that, if we consider an elementary column strip at right angles to the buckles as they exist in this view, its length will still be terminated by the flange angles; the stiffeners are too far apart to be materially effective in reducing this column length, thereby strengthening the web. In the bottom view of Fig. 2 the stiffeners are properly spaced, effectively reducing the length of the column strip, and adding greatly to web strength.

The seeing of these lines of diagonal stress was a revelation to the students, especially to those who were studying reinforced concrete, and who were designing web reinforcement against just this sort of thing.

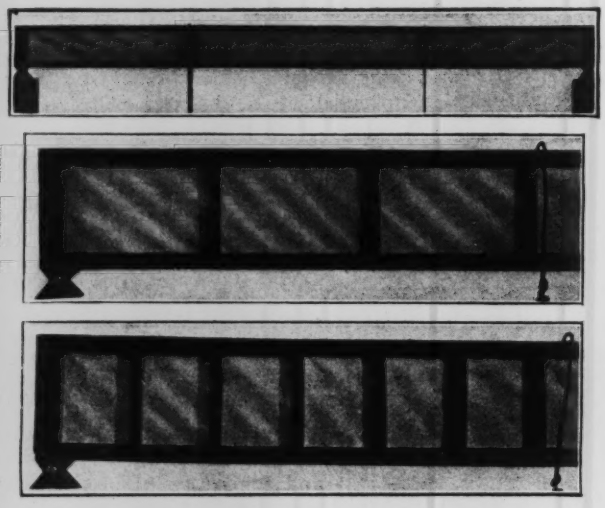


FIG. 2. PAPER WEB EXHIBITS DIAGONAL TENSION

True, they had theorized about these stresses and knew they existed, but seeing them made a great impression, one that they will never forget.

Help to the Student.—In the drafting room, where the students were designing a through plate-girder bridge, the model was found indispensable. Naturally a great many questions arose as to how the parts go together, how splices are arranged, which rivets are field-driven, etc. The model answered most of these questions, or rather it caused the student to answer them for himself, which is still better.

Working two afternoons a week it takes the average student about three months to design and make a drawing of a through plate-girder bridge. Formerly some trouble was experienced in keeping the students interested, but since the advent of this model it has been found that, if they can have it there in the drafting room where they can examine it and handle it, they turn out not only quicker and more intelligent but also more *interested* work.

In conclusion it may be said that we have found this model well worth every cent of money and hour of time spent upon it, and that we are preparing to construct more models along the same general lines to illustrate different types of structures.

Acknowledgements—The bridge model was made by S. F. Styers in the mechanical shops of Johns Hopkins University after plans prepared by the writer. The locomotive model was made by H. E. Askew of the Baltimore Polytechnic Institute. As far as all visible details are concerned it is an exact reproduction of a standard passenger locomotive.

Report on Calcutta Bridge Proposes 1,500-Ft. Cantilever Structure

Reporting on the problem of renewal of the pontoon bridge across the Hooghly River between Calcutta and Howrah, India, a committee of engineers appointed by the government has recommended a fixed bridge crossing the river by a single span of 1,500 ft. with a clearance height of 29 ft. above high water. A cantilever structure is recommended, after consideration of arch and suspension types. Foundations on firm clay are expected to be found between 80 and 100 ft. below surface. The cost of the structure is estimated at $10,000,000.

The old pontoon bridge, built about half a century ago, required extensive repairs in 1916, at which time the old wooden floor system was replaced by steel members. It was known at that time, however, that the bridge as repaired would not be serviceable for more than a few years, and at the present time the construction of the new crossing is imperatively needed.

According to the terms of appointment of the committee, navigation does not require a movable span. A floating bridge was considered by the committee, but the report states that such a structure would not meet the loading requirements because a floor of sufficient strength could not be provided. Suspension or arch construction was rejected by the committee partly on account of the lateral thrust involved and the virtual impossibility of providing suitable foundations in the soft subsoil. Piers in the river are not permissible, either with regard to navigation interests—the commissioners of the port of Calcutta having established the principle that no river piers should be permitted—or with regard to the difficulty of providing piers secure against scour.

Upon these considerations a cantilever design was evolved. As outlined by the committee, the structure would have a straight bottom chord, top chords of the cantilevers sloping down from towers over the main piers to the anchorage end and the suspended span respectively, and curved top chord in the suspended span. Approach grades of 1¼ to 2½ per cent would suit the required street connections.

In view of the heavy traffic demands expected, especially those corresponding to an increased suburban trolley traffic, a total deck width of 100 ft. is suggested as necessary, which would include, besides a double-track trolley line, a 58-ft. width for six lines of vehicle traffic and two 12-ft. sidewalks. The latter would probably be placed outside the trusses. For the floor design the committee recommends that an allowance of 40 per cent impact be made for trolley loads and 50 per cent impact for motor-truck loads.

Immediate prosecution of the scheme is recommended by the committee. The location suggested for the bridge is about 600 ft. upstream from the present pontoon bridge. It is estimated that 3½ years would be required for the construction.

Continuous-Mat Foundations for 22-Story Building

Standard Oil Building in San Francisco Founded on Inverted Floor 3-Ft. Thick, Reinforced by Ribs Between Columns

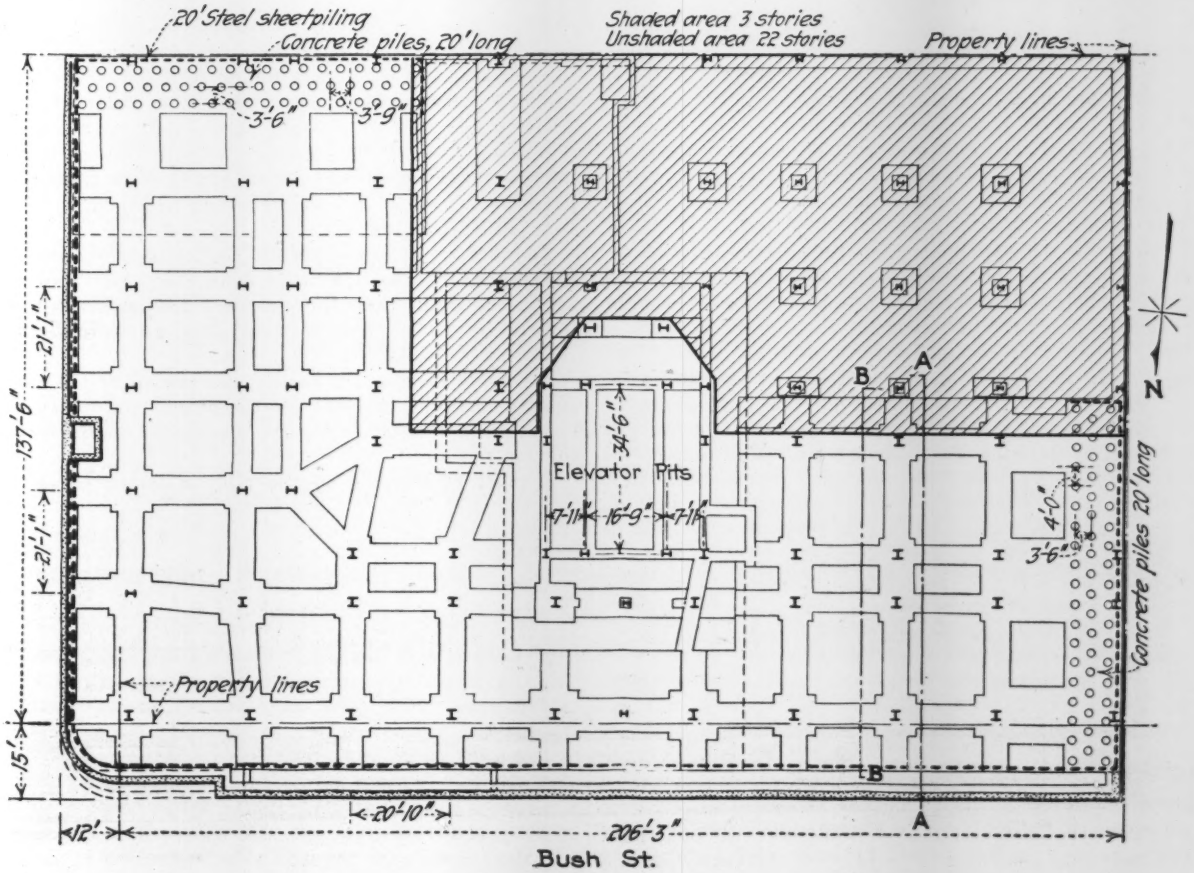
A TWENTY-TWO-STORY office building is now being built for the Standard Oil Co. in San Francisco at Sansome and Bush Sts., which is on the old shore line of San Francisco Bay, about one-half mile inland from the present shore line. Core borings taken on the site showed the underlying material to be sand, clay and water in varying proportions; rock was encountered about 160 ft. below the street level. After a study of local conditions and a comparison of various methods, it was decided to build the structure on a continuous mat of reinforced concrete.

Carrying the foundation down to rock was obviously impossible, or at least impracticable. The use of the ordinary pile foundation was discarded because experience with this type of soil had shown that it would be practically impossible to drive piles through it. The use of jetted piles was considered inadvisable because the underlying strata would have been very much disturbed in the process of getting the piles into position in this way due to the high pressures which would be required for the jet. Moreover, the bearing value of piles in this disturbed material was doubtful. The use of spread footings was then considered. Preliminary computations were made for a design using isolated footings and assuming a soil pressure of 5,000 lb. per sq.ft. This showed that the area of footings needed was such that a continuous mat would be required.

It was then determined to make some compression tests on the soil to actually determine its carrying capacity. Eight tests were made, the apparatus used closely following the type recommended by "The Special Committee to Codify Present Practice on the Bearing Value of Soils for Foundations" in its progress report to the Am. Soc. C. E. which was published in August, 1920, issue of *Proceedings*, p. 906. This apparatus proved easy to construct, very simple to operate and gave excellent results.

The soil loading tests were made in increments of 1,000 lb. per sq.ft. every half hour until a total of 8,000 lb. had been reached. After a lapse of about 24 hr., eight more 1,000-lb. increments were added at half-hour intervals, bringing the total load up to 16,000 lb. As the percentage of sand and clay in the soil varied in different portions of the site in any horizontal plane, uniform results naturally could not be expected. However, as the average settlement recorded by the apparatus for a load approximating the unit dead load carried to the soil by the building (which was about 4,800 lb. per sq.ft.) was less than an $\frac{1}{8}$ in., it was considered amply safe to found the building on a continuous mat.

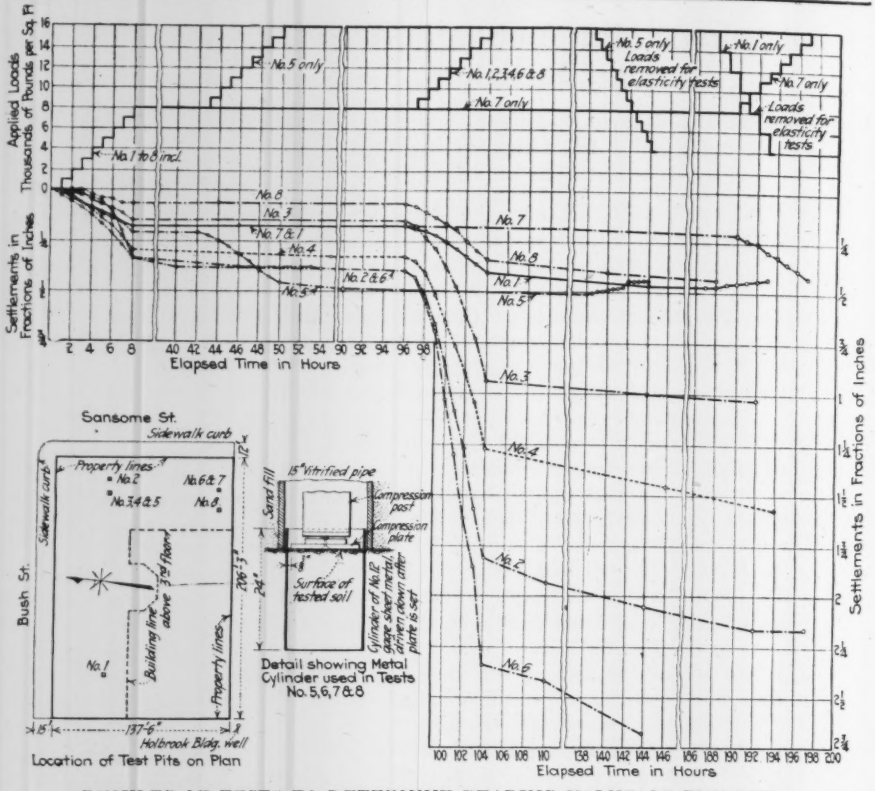
The mat was designed in the customary manner as



PLAN OF FOUNDATION, BASEMENT FLOOR NOT SHOWN

an inverted floor, with ribs extending between the columns. The slab between ribs was designed with two-way reinforcing and, in general, considered as continuous on the four edges. The moments and shears in the ribs were computed on the basis of the theorem of three moments, assuming a uniform soil pressure under the mat. While it was realized that the assumption of uniform soil pressure under the mat is not theoretically true, it was felt that practically, because of the non-uniform character of the soil and the extremely small magnitude of the probable deflections, the assumption was justified.

At the ends of the south and west wings the spread of the mat was limited by the property lines, thereby increasing the soil pressure at these places. To take care of the excess loading along these sides, concrete piles were used. These piles are 20 ft. long and were formed by sinking 18-in. diameter well casing in the usual manner to a hard clay stratum and filling them with concrete.


Applied Loads Thousands of Pounds per Sq. Ft.
Settlements in Fractions of Inches
No. 5 only
No. 1, 2, 3, 4, 6 & 8
No. 7 only
No. 1 to 8 incl.
No. 5 only Loads removed for elasticity tests
No. 1 only
No. 7 only
Loads removed for elasticity tests
No. 8
No. 3
No. 7 & 1
No. 4
No. 2 & 6
No. 5
Elapsed Time in Hours
Sansome St.
Sidewalk curb
Property lines
Bush St.
Building line
Holbrook Bldg. well
Location of Test Pits on Plan
15" Vitrified pipe
Sand Fill
Compression post
Compression plate
Surface of tested soil
Cylinder of No. 12 gage sheet metal, driven down after plate is set
Detail showing Metal Cylinder used in Tests No. 5, 6, 7 & 8

RESULTS OF TESTS TO DETERMINE BEARING VALUE OF THE SOIL

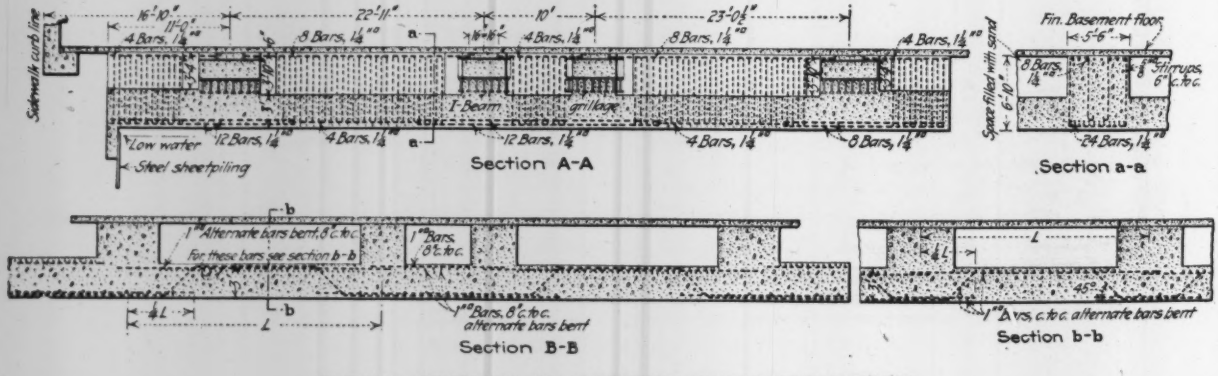
In order to prevent any flow of the subsoil by reason of any future excavation in the streets or adjoining property, interlocking steel sheet-piling was driven near the outside of the mat and entirely around the portion of the area occupied by the 22-story structure. These were in 20-ft. lengths and were driven with a steam hammer without difficulty.

In placing the foundation the site was first excavated, one section at a time, to a depth about 8 ft. below the level of the basement floor. These sections were then leveled off and a 3-in. concrete slab poured to give a clean, dry bed on which to work and lay steel. The bars in the lower slab and bottom part of the ribs were then set and the 3-ft. slab poured. The steel grillages for the column bases were next placed and the remainder of the ribs were formed up, after which the top steel was placed. The next pour finished the ribs and completely embedded the steel grillage. By embedding the grillage in the ribs instead of placing it on top, several feet of excavation were saved and a more compact design was secured. Care was taken that the joint in the ribs at the top of the 3-ft. slab and the vertical joints at the end of the day's pour (which were at center lines between columns) were thoroughly roughened, picked, and painted with neat cement grout just before pouring.

The order of procedure in the excavation and the pouring of the sections was such that the sand used for the back-fill under the basement floor slab was taken by wheel-barrows from the excavation direct to sections ready to be backfilled.

A complication in the design was caused by the necessity of dropping the mat for the pits of the high-speed elevators and trenches for the mechanical equipment in the south wing.

Typical reinforcing of the ribs is shown in section



TYPICAL SECTIONS OF INVERTED FLOOR FOUNDATION

A-A of the accompanying drawing. All the bars were made straight for practical reasons and the shear not taken by the concrete was taken care of by four-legged stirrups, ⅝ in. square. These stirrups were spaced uniformly 6 in. apart in all ribs, which simplified the design and field work and insured a good mechanical bond between the first and second pours in the ribs.

Typical reinforcing in the slabs is shown in section B-B. This was designed by the usual method applied to floor slabs with two-way reinforcing, the bent bars taking shear and negative moment.

The design was made by H. J. Brunnier, consulting structural engineer of San Francisco, by whose office the foregoing data were supplied. George W. Kelham of San Francisco was the architect.

Drilled Wells for Draining Land

By R. M. Downie
Keystone Driller Co., Beaver Falls, Pa.

One of the most curious things found in Florida (and it may be found in other places as well) is the use of drilled wells for the double purpose of supply and drainage. In dry weather the wells may be used as a source of water for irrigating and in the wet season the same wells may be used for draining the land. When the latter purpose only is to be served a 6- or 8-in. well is drilled to a depth of 400 to 600 ft., or until porous rock is found. At this depth the water in the well, which may have previously stood at a few feet below the surface or even have been flowing out, will drop to 20, 50 or more feet from the surface. A little test by turning in a stream of water will show that when the well is filled up a few feet the water will begin to run away.

It only remains to form a brick or concrete sump or settling basin 10 or 12 ft. in diameter about the top of the well, to catch all drift or sand, as otherwise the well will in time be choked. The well casing is cut off at 3 to 8 ft. below the ground and 18 or 20 in. above the bottom of the sump. This allows the surrounding land to be drained into the sump and in this way the level in small lakes may be kept at a predetermined height during the wet and dry seasons. Sewage from small towns and cities may be disposed of by passing it through a septic tank and then conducting the effluent to the well. The outlet from the wells is always some hundreds of feet below sea-level and the sewage does not at all contaminate the underground water.

If a well is made for obtaining water, usually a depth of 100 to 150 ft. will yield all that can be pumped.

[Drainage by means of wells has been practised in the central and western states, as noted in *Engineering News-Record*, Dec. 10, 1914, p. 1169, and *Engineering News-Record*, July 19, 1917, p. 120.—Editor.]

Spray Painting Tried on Bridges

Painting bridges by compressed air was given a tryout recently by the maintenance department of the Indiana Highway Commission, John Williams, director of maintenance. Because of the increasing number of bridges taken over by the commission, economy in maintenance is increasingly important, and a cheaper and quicker method of painting than hand brush work is desired. It is reported that the test showed the spray painting to be considerably cheaper than hand work.

Irrigation Works in Formosa Being Built by Japan

Dry Side of Island to be Irrigated by a Diversion from West Side—Bricks for Tunnel Lining Carried 14 Miles by Cableway

Two crops per year instead of one may be raised on the dry side of the Island of Formosa when the Japanese finish irrigation works now under construction, consisting of the diversion of a river by means of a tunnel bored through a mountain, a storage reservoir, 638 miles of ditches and an equal mileage of drains.

Formosa, or Taiwan, as it is called in Japan, is an oblong-shaped island with a high mountain range extending through the center from north to south. On one side of the range is the Sabon River, offering an ample water supply; on the other side of the mountains is a fertile area, needing more water. The land is cultivated

JAPANESE GANG ERECTING AMERICAN MACHINERY

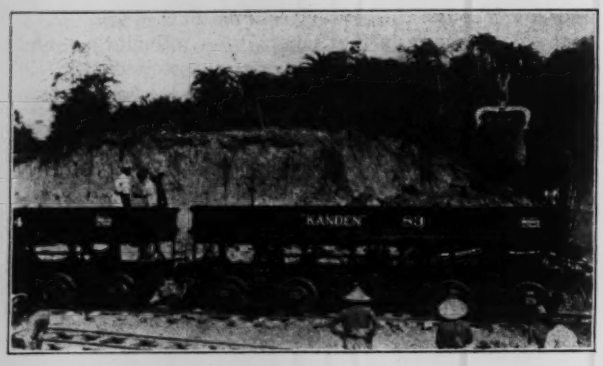
by Chinese farmers, whose ancestors settled there a thousand or more years ago. They have made some crude attempts at irrigation, but the water supply is insufficient. The entire rainfall is confined to the months from June to September and in consequence sugar cane is the only crop raised. A young Japanese engineer, Y. Hatta, conceived the idea of carrying the waters of the Sabon River through the mountain range by means of a tunnel, so that by irrigation the farmers could raise a crop of rice after their sugar cane had been harvested. This was in 1914. It took him three years to convince the government of the feasibility of the enterprise, but finally in 1917 Japan decided to undertake the project. The Kanden Irrigation Assotion was formed to handle the work and Mr. Hatta was made chief engineer. The preliminary work is now well out of the way and actual construction has commenced. The following information on certain details and methods of construction was brought from Japan recently by R. E. Bressler, of Aurora, Ill., works engineer for the Western Wheeled Scraper Co., who went to Formosa last summer to install American-made air-dump cars on the work.

One mile of the tunnel will be through solid rock. The bore will be a half-ellipse in form, 18 ft. wide at the base and 18 ft. high; it will be brick lined. To make the 20,000,000 bricks required for the lining, a factory has

been built having a capacity of 5,000,000 bricks per month, in which bricks are being made at a cost of 0.7c. each.

The method of handling these bricks is interesting. The factory is 7 miles from the nearest end of the tunnel and the bricks are conveyed across the mountain by 14 miles of endless cable mounted on towers. At the factory the cable delivers the empty material buckets on to an overhead track which feeds the loaded buckets back on to the cable at the other end.

The dam, on which work was to start about April 1, will be 170 ft. high, 4,500 ft. long at the top, 1,000 ft. wide at the bottom and 50 ft. wide at the top. It will be of semi-hydraulic construction. A concrete core will extend 50 ft. below ground and 50 ft. above ground.



LOADING AMERICAN AIR-DUMP CAR IN FORMOSA

Earth and stone for the embankment must be brought from the river bank, requiring a railroad haul of 10 miles. It was for this haul that 16-yd. automatic air-dump cars were installed. These cars and the railroad which is now under construction, conform to the standard gage in Formosa which is 42 in. German locomotives will pull the trains.

The reservoir will be 7 miles long and 4 miles wide, resembling, on the map, a piece of coral, as the water will back up into innumerable small valleys. On this account it is called Coral reservoir. Its maximum capacity is 5,500,000,000 cu.ft. of water. The area of the district to be irrigated is approximately 47 miles long by 17 miles wide. There are to be 638 miles of supply canals and an equal mileage of drainage ditches. The largest canals, of which there are 100 miles, will be 90 ft. wide at the top and 7 ft. deep. To build these large canals the Japanese will use an excavator of their own, designed and manufactured in Japan, resembling somewhat an American trench machine except that it works sidewise.

The Kanden Irrigation Association has established headquarters with an office force of 120 Japanese at Kagi. It has built houses there for 56 families. A whole town, called Usanto, has been built, with houses for 300 families, waterworks, brick factory and shops. At present 100 Japanese and 400 Chinese are working at Usanto, the former in a supervisory capacity. Eventually from 2,000 to 3,000 men will be employed.

The total cost of the project will be 45,000,000 yen, a yen being about 50c. in American money. It is estimated that the value of the crops will be increased by 15,084,887 yen annually and that the increase in the value of the land in consequence will amount to 96,907,200 yen.

It is worthy of note, says Mr. Bressler, that this great benefit will not accrue to the Japanese people directly, but to the Chinese farmers, whom Japan found on the land when Formosa was taken over from China at the close of the Chino-Japanese war. Half of the entire cost of the project to benefit the natives of the island will be paid by the government of Japan; the other half by the farmers to be benefited. The plan is to complete the payments in ten years, after which there will be no further direct cost to the farmers, the government taking care of the maintenance.

When Formosa came under the control of Japan, 26 years ago, there were no improvements on the island. Today, according to the observations of Mr. Bressler, there are railroads, beautiful parks and buildings, including one of the finest hospitals in the world. A breakwater, costing about 15,000,000 yen, is being built at Takao to create a great sugar harbor; there is a harbor development at Kellung and a hydroelectric development in the central part of the island.

Public Health and Sanitary Engineering Work at Harvard Revised

TWO announcements of interest to engineers and sanitarians have just been made at Harvard University—the reorganization of the School of Public Health and a new programme of studies in the Engineering School leading to a master's degree in Sanitary and Municipal Engineering.

The Harvard School of Public Health will take the place of the school which since 1913 has been conducted jointly by Harvard University and the Massachusetts Institute of Technology, the new school being in fact the outgrowth and continuation of the older one. There will still be active co-operation between the University and the Institute, but the administration will henceforth be wholly under Harvard University, a plan made necessary by the fact that the recent munificent gift, known as the Henry P. Walcott Fund, from the Rockefeller Foundation was to Harvard University. The older school had no power to grant degrees, but students will now have opportunities to study for degrees in public health granted by the Harvard Corporation—namely, Bachelor, Master and Doctor of Public Health. The medical degree is not a prerequisite for candidates for the bachelor's or master's degree, but it is required for the doctorate in public health. The Harvard School of Public Health will have its own faculty and its own organization, although it will be adjacent to the Harvard Medical School and naturally affiliated with it in a very close way. Dr. Edsall, the Dean of the School of Public Health, is also Dean of the Medical School.

Courses Arranged on the Intensive Plan — The courses of study are arranged upon the intensive plan. For example, students will spend the forenoons of every day during October and November in Prof. Whipple's Department of Sanitary Engineering; the forenoons of December and January in Prof. Wilson's Department of Vital Statistics; the forenoons of February either with Dr. Drinker studying Ventilation and Illumination or with M. C. Whipple, studying Water and Sewage Analyses. The afternoons are more sub-divided and are devoted to such subjects as bacteriology, physiology, preventive medicine, epidemiology, public health administration, and the like.

The growing importance of vital statistics in public health work is shown by the fact that Prof. E. B. Wilson, recently head of the Physics Department of the Massachusetts Institute of Technology, has been made full professor of Vital Statistics in the Harvard School of Public Health. He will take over the course in that subject which Prof. George C. Whipple has been giving during the past ten years, thus enabling Prof. Whipple to devote his attention to the teaching of sanitary engineering and to his professional work. The Department of Public Health Administration is not yet fully organized, but temporarily this subject will be in charge of Dr. M. J. Rosenau, assisted by a professor in the Law School, and by Prof. C. E. Turner of the Massachusetts Institute of Technology, who will give lectures in Public Health Education.

Five-Year Program of Engineering School—The change in the Harvard Engineering School consists in the establishment of a fifth-year programme leading to the degree of Master of Science in Sanitary and Municipal Engineering following the regular four-year programme in civil engineering. It has been found by experience that a four-year course is not long enough to cover both the fundamental subjects of engineering and the special work required for this branch of the profession. The Engineering School will maintain its present four-year programme in Sanitary Chemistry and Biology.

As in the School of Public Health, the programme of Sanitary and Municipal Engineering is arranged on the intensive plan. A laboratory course in chemistry and biology extends through the year, and a new course in hydrology, which will include meteorology and limnology as well as the hydraulics of rivers, will extend through the first term; but four of the principal topics will be taken up intensively, half of the students' times for two months each being devoted to water purification, water-works management, sewerage design and sewage treatment. There will be no lectures in these four courses, each student working individually with the instructor, taking up a series of practical problems of considerable magnitude, thus applying to engineering instruction the case system so well known in the Harvard Law School and recently adopted in the Harvard School of Business Administration.

Chance to Specialize in Water Supply and Sewerage—Moreover, the courses are so arranged that the general subject of water supply is treated during the first term and sewerage during the second term, thus making it possible for special advanced students to attend either term in case they can obtain a leave of absence of only four months from their regular work. Another innovation is that a considerable part of their work will be done in the field, advantage being taken of the many sanitary works in the vicinity of Boston. It is hoped to make the first term the beginning of a movement to train men for the water works business.

Gordon M. Fair, who has recently returned from sanitary work with the League of Red Cross Societies in Europe, has been appointed Instructor in Sanitary Engineering and will teach both in the Engineering and in the Public Health Schools.

The Harvard Engineering School is now entirely separate from the Massachusetts Institute of Technology; but as both institutions are now located in Cambridge, only a few miles apart, the opportunities for the exchange of academic courtesies are obvious.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Highway Bridge Safety

Sir—Your editorial remarks p. 1023, June 22, are right in their assertion that the state is at fault in the matter of bridge accidents, for not placing the planning of important bridges and roads in the hands of competent engineers. To convince the voters of this fact is a matter of education. The work of state highway departments should educate the people to the point where important engineering work in connection with highways, bridges, and the like will be placed under the administration of the state highway department. I believe that progress is being made in this direction.

Such articles as the one on the failure of the Marlin bridge will be helpful in calling the attention of the public to the importance of employing competent engineers for important engineering work. BRIDGE ENGINEER.

June 28.

Backwater Suppression

Sir—I note in *Engineering News-Record*, June 8, 1922, p. 964, an article describing some special features of the last Coosa River hydro-electric plant, especially the "backwater suppression" by the effect of spillway overflow on the tailwater at the toe of the dam.

This is not an innovation in any sense; like results were obtained in a hydro-electric plant on the Patapsco River near Ellicott City, Md., by utilizing my program and design of the submerged power house located in the interior of a concrete-steel dam where turbine water is drawn through the deck and discharged at the toe. This plant has operated for about 16 years with practically steady head no matter what the spillway overflow is.

matter what the spillway overflow is. H. VON SCHON,

South Bend, Ind., June 30. Consulting Engineer.

Lost in Russia Five Years, Surveying Instruments Return to U. S. A.

Sir—We have had a rather curious experience in having had returned to us a shipment of instruments which we sent to a dealer in Moscow, Russia, in October, 1916. For about two years we tried to collect this account, but due to the mails having gone bad we concluded that the shipment was lost and practically forgot the matter.

About six months ago we received notice from the Foreign Department of the American Express Co. in Vladivostok, Russia, stating that a case of instruments bearing our name as shippers was in their storehouse and that if we would guarantee the return charges, the case could undoubtedly be returned to us. We agreed and the instruments finally reached our factory after an interval of about five years.

Three levels, one transit and one current meter, constituting the shipment, were found to be in absolutely first-class condition, after having been subjected to all kinds of rough handling, great variations of temperature, etc. It would seem that this is a splendid testimonial to the excellent care used in packing, both of the instruments within their respective boxes and the outside packing and waterproofing. It is also a splendid testimonial of the care with which the American Express Co. looks after the interests of its clients.

I am giving you these facts, as it occurred to me that

they might be of interest to readers of *Engineering News-Record*. It is certainly rare to cast bread upon the waters and have it come back to you after such a long interval.

H. M. DIBERT,
Troy, N. Y. Sales Manager, W. & L. E. Gurley.

Foundation Pressures in Multiple-Arch Dams

Sir—The circumstances no longer making anonymity desirable in connection with the query on multiple-arch dam foundation pressures, which appeared in your issue of April 13, "Enquirer" will now assume his rightful name and such responsibility as may attach.

I have read with great interest and satisfaction the replies of Mr. Nishkian and Mr. Noetzli in your issue of June 15. Certainly it would have been difficult to secure expressions from two more highly qualified authorities, and the fact that they are both in entire accord with my method of analysis is very gratifying. Judging by appearances only, it may seem that I am in error in including Mr. Noetzli in this category, but such is not the case, as will be shown. In fact, the entire accord between Mr. Noetzli's method of analysis and that used by me is the more remarkable because of the wide divergence of mathematical method.

The subject presented being one of no mean importance, the discussion open to all comers, and personal invitations to participate having been extended to certain engineers who presumably held opinions differing from those of the writer, it is significant that no one came forward to champion the "free-body buttress, total load" scheme which has enjoyed popularity in certain quarters, and to which the writer took exception.

It is evident that Mr. Nishkian is in entire accord with the writer's method. As he states, this involves certain assumptions which are never exactly fulfilled, but are sufficiently approximated to satisfy the conditions imposed. Of course, the same comment applies equally to all accepted methods of foundation pressure determination, in any case, and to a certain extent to all methods of stress determination in any structure or structural member. The only plausible argument which could be advanced against the use of this method of analysis in connection with the multiple-arch dam, is that one based upon the assumption of the relative flexibility of the arch footings as compared to those of the buttress. The writer is inclined to believe that such critics would over-rate the flexibility of the arches under such stress. Furthermore, unless the form and dimensions of the multiple-arch dam are very greatly modified from the present standard, the compression under the arch rings will be so relatively small that there is no question but that the rigidity of the arch will be sufficient to absorb this loading without appreciable deformation. Certainly, if an analysis by my method shows tension at the arch crown, the arch deformation argument has no place in the discussion. Finally, as Mr. Nishkian says, the method may not give results which are in absolute harmony with the actual facts, but it does approximate these facts as closely as any method could be expected to, and possesses the merit of leaning on the side of safety.

Concerning the apparent discrepancy as between the results by Mr. Noetzli's method and that employed by me. This is due to his use of certain statements which appeared in my letter, and which were grossly in error. The responsibility for this, however, belongs to the designer of the dam, since in these statements I merely quoted him, and so stated in my original letter.

In my previous letter I stated that the designer of the particular dam in question, under the "free-body buttress, total load" method used by him, found pressures of about six and eight tons, respectively, at the ends of the abutment. And so he did, as the exhibits and statements submitted by him show, but his results bear no relation whatever to the primary data as shown by him and from which they must necessarily have been derived. I did not check his stated results previously. At the time of writing my previous letter, time was the essence of the situation, and I was too busy with my own analysis and results to bother with an investigation of the accuracy of his. Since then the same condition has obtained, and my attention has only now been called to his error through the results obtained by Mr. Noetzli.

Mr. Noetzli, desiring to find a starting place for his work, very naturally seized upon the stated pressures as given by the "free-body buttress" method, and these being in error it follows that all of his deductions therefrom are also, as respects the actual conditions of the given problem which were used by me in deriving my stated results under the "monolith" theory. Referring to Mr. Noetzli's sketch and nomenclature, as given in his letter the actual data are as follows:

$P_o = 4010$ tons $\quad A = 570$ sq.ft. $\quad a_o = 37.3$ ft.

$d = 62.2$ ft. $\quad c = \begin{cases} 26.1 & \text{(Noetzli notation)} \\ 51.0 \text{ \& } 37.3 & \text{(Notation } Mc/I\text{)} \end{cases}$

I, about axis through c.g. of area $= 443{,}600$
Eccentricity of P_o about c.g. $= 24.9$ ft. toward toe
e = distance from axis 1 - 1 to neutral axis, $= a_o - z$.
z = distance from c.g. to neutral axis
x = distance from neutral axis to P_o

By changing the value of I to conform to the neutral axis as the plane of reference, we have all of the necessary data for substitution in both Mr. Noetzli's formula and that one used by me. This is done and the consequences shown in the two solutions which follow:

Solution by formula, $f = P/A \pm Mc/I$.

$$f_1 = \frac{4010}{570} + \frac{4010 \times 24.9 \times 51}{443{,}600} =$$

$$7.03 + 11.47 = 18.50 \text{ tons per sq.ft.}$$

$$f_2 = \frac{4010}{570} - \frac{4010 \times 24.9 \times 37.3}{443{,}600} =$$

$$7.03 - 8.39 = -1.36 \text{ tons per sq.ft. (tension)}$$

$$z = \frac{4010 \times 443{,}600}{570 \times 4010 \times 24.9} = 31.2 \text{ ft.}$$

$$e = a_o - z = 37.3 - 31.2 = 6.1 \text{ ft.}$$

For derivation and proof of the above formulas, see pages 214 and 215, Merriman's "Mechanics of Materials," 11th Edition.

SOLUTION BY MR. NOETZLI'S FORMULA

$$I_{1-1} = 443{,}600 + (570 \times 37.3^2) = 1{,}236{,}600$$

$$S_1 = 570 \times 37.3 = 21{,}261$$

$$e = \frac{1{,}236{,}600 - (62.2 \times 21{,}261)}{21{,}261 + 570\ (62.2 - 2 \times 37.3)} = -\frac{85{,}800}{14{,}193}$$

$$= -6.04$$

$$S = 21{,}261 - 570 \times 6.04 = 17{,}818$$

$$f_1 = \frac{4010 \times 82.1}{17{,}818} = 18.48 \text{ tons per sq.ft.}$$

$$f_2 = \frac{4010 \times -6.04}{17{,}818} = -1.36 \text{ tons per sq.ft. (tension)}$$

A comparison demonstrates that the results are identical as given by both formulas, within the requisite or expected limits of accuracy, and that the values as derived by me, using the monolithic theory, as stated in my original letter, were correct. Of course, only approximate values were noted there, since the matter involved was one of general theory and not of numerical values.

It is apparent that the solution by use of the general formula, $f = P/A \pm Mc/I$, involves considerably less labor than does Mr. Noetzli's. It has the additional advantage of being more direct in application and more generally known and understood. I compliment Mr. Noetzli upon the mathematical genius displayed in the development of his new formula, but it would appear that for all practical purposes the old keystone formula of structural science will serve us better.

Under the application of the "free-body buttress" method, using the data as before established, the correct value of f_1 is 19.9 tons per sq. ft., and of f_2 is 2.7 tons, both

compression. For this particular case, therefore, there is actually no great difference in the value of f_1 as obtained by the two different methods of analysis. The difference in the values of f_2 is very important, because of the consequent radical change in stress distribution which follows. The "monolith theory" shows that there is tension at the crown of the arch footing, whereas the other shows nothing, but indicates compression. It is suggested, however, that it would be a mistake to attempt any generalizations as to the relative effect of applying these different methods of analysis, since the difference in derived values will depend entirely upon the conditions of the particular problem under consideration. It is to be remarked also that in what has preceded, it has been assumed for the purposes of this discussion that the section is capable of taking tension, which may or may not be true as concerns any given problem.

Mr. Noetzli states that my use of the general formula, $f = P/A \pm Mc/I$ is correct, but that I apparently used the wrong axis for I. It is my understanding that in this formula, I is always taken with respect to an axis perpendicular to the plane of bending, and passing through the c.g. of the static area. (See page 428, Spofford's "Theory of Structures.") I have so used it in the preceding solution, and since the results obtained are identical with those by Mr. Noetzli's formula, it appears that he was in error in this matter. Obviously, had I used the axis suggested by him, there would have been no similarity between the results.

At the time of writing my previous letter, I was aware that there was nothing original in my use of the proposed formula for determining the distribution of stress, but I had been unable to find any authority in technical literature for applying it to this particular case. Since that time, additional research has developed the fact that the "monolith method" of analysis is described and advocated by W. P. Creager in his book, "Engineering for Masonry Dams," particularly on pages 45 and 140, and by Wm. G. Bligh on page 116, Vol. IX, "Cyclopedia of Civil Engineering." The last-named treatment is very brief and lacking in detail, but is conclusive nevertheless. I further find that my criticism regarding the writers of text-books is inapplicable in at least one instance. In C. M. Spofford's "Theory of Structures," pages 428 to 430, he gives a very clear exposition of the derivation and characteristics of the formula, $f = P/A \pm Mc/I$. Quite possibly there are other texts which give an equally clear and direct explanation, but I have not had the pleasure of seeing them.

S. M. COTTEN ("Enquirer").

Phoenix, Ariz., June 27.

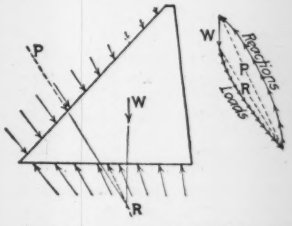
Sir—We have read with interest the answers in your issue of June 15 to the communication of "Enquirer" in your issue of April 13, 1922, p. 623, and as it does not seem to us that the question propounded has been very clearly answered we submit the following:

The inquiry was as to what part of a foundation in general should be considered as carrying the load, and in particular whether the footings under the arches of a multiple-arch dam should be included with the buttress footings is computing foundation pressures. The question as stated in its general form cannot be answered as each case must be considered on its own merits, but a little consideration of the formula $f = P/A \pm Mc/I$ will be helpful to an understanding of its applicability to a given case. The expression gives the stress on the extreme fiber of a combined beam and tie or struct whose length is several times its width and it is based on the assumption that sections plane before loading remain plane after loading, from which it follows that the stress varies uniformly over a right section. The expression may also be reasonably applied to compute the pressure on an earth foundation on the assumption that the intensity of pressure is proportional to the amount the earth is compressed.

It may, of course, be applied to a rock foundation just as it may be applied to find the stress on any horizontal section of the structure above the footing, but if the structure has a form which bears little resemblance to the usual forms of beams, there is small reason for thinking that stresses computed from the beam formula will give accurate results. The pressures on any foundation must be produced by the stresses in the structure itself just above the foundation.

To pass to the given case of the multiple-arch dam; it would seem, if such a structure were built on earth, which is much more yielding than concrete, that the structure could be considered as a rigid whole in relation to the foundation and that the part of the footings under the arches would carry its share of the load, provided the arch barrel were strong enough to help distribute the load. There could be no tension on the footing although "Enquirer" computed one. Any part of the footing under tension should be eliminated from the area of the computations and a new area found by trial to fit the condition that the pressure at its edge shall be zero.

But if the dam rests on rock, the reasonable method of computation is to consider the load to be carried by the buttress footings, since the lower part of the arch is not stiff enough to throw much load on the curved footing. The full arch ribs throw their loads into the buttresses through which the loads can pass directly to the buttress footings and only a few short ribs near the base apply a load to the curved footings. Any considerable reaction over this part of the base would produce bending moments in the elements of the cylinder. There can be little question that the method of computation employed by the designer of the dam, who considered that the abutment footings carried all the load, was the better one to employ for a rock foundation. Of course, there is not an abrupt change of pressure from six tons per square foot to zero where the footing forks, and, indeed, a part of the footing under the arches near the buttress might well be included with the abutment footing, but how much is a matter of judgment. Presumably the intensity of pressure changes rapidly there. But rather than to assume the entire load on the structure to go to the abutment footing, it is better to pass a plane through the upstream end of the base of the buttress so that the plane separates the complete ribs, which spring from the buttresses, from the short ribs which rest on the ring footing and to assume that the load above the plane passes into the buttress and through it to the buttress footing and that the load below passes into the ring footing, a division of load which probably is not far from what actually exists.



In this connection the accompanying sketch showing the buttress as a separate member of the structure may be of interest. The load from the arches, P, and the weight of the buttress, W, are resisted by the reaction, R, which cuts the center of the base making the vertical component of the stress on the base constant. If R were eccentric the distribution of the vertical component could be computed by the formula mentioned above. At the toe the direction of stress is along the downstream edge of the buttress and the probable direction of stress at other points on the base is found by sketching in a polygon on R in the force diagram having the given direction at the lower end.

In solving problems of unusual type it is well to remember that rules and formulas derived from certain definite assumptions will not give exact values when mechanically applied to cases where the conditions do not fit those assumptions. It is quite out of the question to compute the distribution of pressure on a foundation with any such accuracy as we can compute the stresses on the cross-section of a steel beam for instance; the best we can do with a foundation is to make reasonable assumptions and find approximate stresses.

GARDINER S. WILLIAMS,
ALBERT E. GREENE.

Ann Arbor, Mich.
June 23.

NEWS OF THE WEEK

New York, July 13, 1922

Plan 30 Miles of Sewers to Relieve Los Angeles

Temporary Works To Be Built—Vote Aug. 29 on $13,000,000 Loan for Outfall and Screens

Staff Correspondence

Progress is being made on measures for both temporary and permanent relief of the overcharged ocean outlet sewer of Los Angeles, Cal. An election is to be held Aug. 29 to vote on a $13,000,000 bond issue for a new outfall and branches and for screens. The outfall is designed to serve a metropolitan district now under consideration.

For temporary relief, Imhoff tanks and sprinkling filters in units of 1½-m.g.d. to be built successively as needed are proposed. Two of these units are to be built at once at a point below Culver City to handle the present overflow of untreated sewage into Bellona Creek above Culver City. In return for a right-of-way through Culver City, Los Angeles is to care for its sewage.

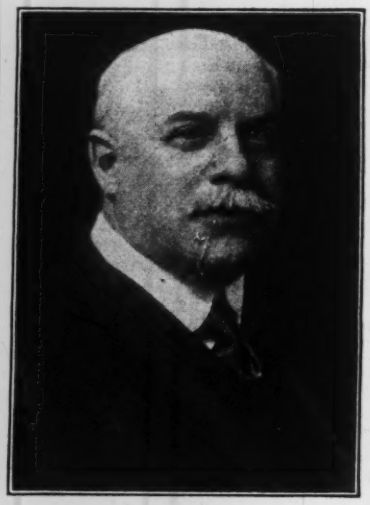
Bids were received July 3 for one mile of the 44-in. riveted-steel connecting sewer from Arlington to Mesa Drive. Bids for the remaining four miles will not be invited until all the rights of way have been obtained, but it is expected that the sewer and sewage-works can be finished within the three-month period called for by the court injunction against discharging untreated sewage into Bellona Creek. (See *Engineering News-Record*, Feb. 23, p. 336, March 2, p. 343, April 13, p. 596 and 618, and May 11, p. 806.)

Knowlton Gives Facts

For permanent disposal works which the city officials have concluded should be an outfall into the sea, near Hyperion, ultimately to care for a metropolitan district, a bond issue if $13,000,000 is to be voted upon on Aug. 29. Conferences are being held between officials of the various cities in the proposed metropolitan district, and at one on June 3, W. T. Knowlton, engineer of sewers, Los Angeles, outlined the situation as follows: Population increases have been so rapid that the present outfall, completed in 1907 for a population of 500,000 people, is now heavily overcharged and by 1925, if the present rate of increase persists, a population of 1,000,000 will be attained. Since the Fernando Valley has become a part of the city, requests have come in for sewerage system installations from various portions of the valley. For the present, disposal can be handled to the best advantage locally but as soon as the new outfall is completed extensions should be made to Burbank, Glendale and other cities to the north.

In an earlier statement to the public Mr. Knowlton gave the length of new outfall and main trunk sewers as 30 miles, reaching from the sea to the junction of the Los Angeles River and the Arroyo Seco. The ocean end of the outfall will be 12 ft. wide and 13 ft. high. Discharge after screening is to be at a point ½ mile from shore.

The Newly Elected President of the American Society for Testing Materials



Dr. George K. Burgess

Motor Traffic Banished from Brooklyn Bridge

Motor traffic is no longer permitted to use the Brooklyn Bridge, according to rules recently published by the commissioner of plant and structures of New York City. Under the same regulations horse-drawn traffic is not to use the Manhattan Bridge, the next bridge to the north in the series of bridges that cross the East River. According to the official announcement, the effect of the new regulations will be to avoid delays and the danger of accident on both spans that has resulted from mixing horse-drawn and motor traffic.

The point is made also that the loads on the roadways of the Brooklyn Bridge will be reduced and more uniformly distributed, although no statement has been made to indicate that the question of strength was dominant in deciding as to the change.

Short-Circuit Causes Near-Panic in New York Subway

Fire caused by a short-circuit on a panel board of one of the cars almost created a panic in a New York subway train on July 6. The accident occurred on the north-bound track of the Lexington Ave. route near 59th St. just before noon. Fortunately the train was not crowded and the passengers were able to gain access to the street through a nearby emergency exit. No fatalities have been reported but about 150 required treatment for the effects of smoke and fright. Investigations have been ordered by the City of New York, the Interborough Rapid Transit Co., and the New York Transit Commission.

To Study Concrete Specifications

At the recent meeting of the executive board of the Associated General Contractors, L. C. Wason, speaking for Col. Whitson, chairman of the A. G. C. special committee on concrete specifications, reported that the committee had concluded that the making of tests in various parts of the country by contractors, as suggested by Richard L. Humphrey, chairman of the Joint Committee on Concrete and Reinforced Concrete, would be futile and would not warrant the expense and trouble involved. The executive board after full discussion sustained the opinion of the special committee and disapproved the suggested series of tests.

The committee, however, was continued and authorized to prepare specifications for concrete and reinforced concrete, which in its opinion would be proper and reasonable. It is understood that it is not the intention of the contractors' committee to publish concrete specifications in competition with those of the joint committee of the engineering society, but that it was considered that the preparation of specifications would be the best way for the contractors to bring their ideas to the consideration of the Joint Committee, which has prepared tentative specifications, many features of which are not satisfactory to the contractors engaged in concrete work. Co-operation, not opposition, is intended.

Conferences Being Held on Lumber Standardization

A series of conferences began at the U. S. Forest Products Laboratory at Madison, Wis., July 12, to be continued at Chicago, July 20, and terminated at Portland, Ore., July 27, which have as their chief aim standardization in grade marking, simplification of grades, and inspection of lumber. The conferences are being participated in by representatives of national lumber manufacturing concerns, lumber wholesalers, retailers, representatives of technical building professions and trades, and those of interested government bureaus.

The Madison meeting will last a week and will deal with the simplification of grades and names and will be chiefly a conference of engineers and technical experts. On July 20 a committee representing the fourteen softwood and hardwood lumber producing associations will meet in Chicago to hear and consider the report of the technical committee on simplification of grades and names. During the next two days consideration will be given not only grades and nomenclature but grade marking and size standardization and the organization of a lumber inspection service.

At Portland July 27 discussion of simplification of grades and names, grade marking, standardization of sizes and national inspection will be had.

Hydraulic Conference in South Results in Permanent Body

As the result of a conference attended by the most outstanding men in hydraulic engineering in the southern states, together with representatives of private utilities and government agencies, held in Asheville, N. C., June 20-22, a permanent body to be known as the Southern Appalachian Water Power Conference was organized. Col. Joseph Hyde Pratt, director of the North Carolina Geological & Economic Survey, was named president, the other officers being: vice-president, Lincoln Green, first vice-president of the Southern R.R.; secretary, Prof. J. A. Switser, of Tennessee; and treasurer, Thorndike Saville, chief of the division of water resources of the North Carolina Geological & Economic Survey. Meetings of the conference were unusually well attended and papers were presented discussing the great possibilities of water power development in the southern states and the advantages to be derived from co-operation of all agencies involved.

The federal government was represented by N. C. Grover, chief hydraulic engineer of the U. S. Geological Survey; O. C. Merrill, executive secretary of the Federal Power Commission; C. H. Birdseye, chief topographer of the U. S. Geological Survey; C. V. Hodgson, of the U. S. Coast and Geodetic Survey; T. W. Norcross, chief engineer of the U. S. Forest Service; Col. H. B. Ferguson, assistant secretary of war; and Warren E. Hall, district engineer, U. S. Geological Survey.

The conference was considered a step toward the inauguration of complete co-operation among hydro-electric utilities, the federal and state commissions and promoters of water-power development. It is expected that as the work of the conference gets under way it will mean much for the development of water power in the South Atlantic states.

Various committees were appointed which will submit reports at the next meeting of the conference. One of these committees, on Energy Supply, will study location of undeveloped water powers in the southern Appalachian states, the order of development, the location of auxiliary steam plants, making of water-power surveys, taking of stream-flow measurements, the problem of silting, etc. Another will treat of inter-connection of the various power developments, and a third will consider proper federal and state legislation to aid in water-power development.

State Road Testing Engineers Get Together

The Committee on Tests of the American Association of State Highway Officials met with the officials of the U. S. Bureau of Public Roads in Washington on June 26 and 27 for further consideration of standardization of specifications and tests for road materials. The purpose of this meeting of representatives from all sections of the country was not so much to lay down rigid rules as to harmonize the general practice. Standardization taking into account local conditions is being brought about by a series of meetings between officials from groups of states and engineers of the bureau.

Appropriate $580,000 for Narrows Tunnel

The Board of Aldermen of New York City has appropriated $580,000 for preliminary expenses in connection with the construction of the proposed passenger and freight tunnel under the Narrows connecting Brooklyn and Staten Island. This tunnel has occasioned much controversy in technical and political circles because of its alleged interference with the Port Authority project for harbor improvement, which contemplates a freight tunnel farther up the bay. An injunction against the Narrows tunnel brought by the Citizens' Union, a civic organization, was recently dissolved as recorded in *Engineering News-Record* June 22, 1922, p. 1054.

Large Hard-Rock Heading Makes Record Progress

Record progress was made in a heading driven from Adit 1, Tunnel 3, of the Southern California Edison Co.'s Big Creek project during March, according to word received from the company. The month's progress of the heading was 476 ft. Ever since the opening of the adit, work has been in extremely hard granite, so hard that on many shifts three sets of drill steel were required for each hole.

The tunnel is 21 ft. square and is excavated to full size by a heading and a short bench. On the average forty-two holes are drilled for the heading and eighteen for the bench, the former being about 18 ft. deep while the bench holes range from 18 to 20 ft. One round is shot in 24 hr., making an advance of 12 to 17 ft. The firing is so arranged that the cut holes of the heading are shot first, then the lifting holes of the bench, and last the side holes of the heading. The total powder consumption is 1,500 to 2,000 lb. dynamite per round. Eight machines are used in the heading and six in the bench. They finish a round in 6 to 10 hr. Two 80-man shifts are worked. Mucking is done with steam shovels of standard size, operated by compressed air. The muck cars are hauled by electric locomotives of both battery and trolley types.

Knickerbocker Defendants Deny Joint Responsibility

Counsel for the five men indicted in connection with the roof collapse of the Knickerbocker Theater in Washington on Jan. 28 recently moved to have the indictments quashed. In arguing the motion they denied that the architect, the contractors, the superintendent, the inspector, and the material men engaged in constructing the theater are jointly responsible for each other's work to the extent of being liable to be held for the collapse of the building. Decision on the motion has not yet been rendered.

Invitations Out for International Engineering Congress

Definite arrangements have been made to hold an International Engineering Congress in Rio in connection with the Brazilian International Exposition which opens September 7 and will last until the end of March, 1923. The congress will be held under the auspices of the Brazilian government Sept. 7-30 inclusive. Invitations have been issued to all engineering societies in the United States and Canada and through them to members of the societies to participate. The Engineering Club of Rio is officially charged to organize the congress.

The principal subjects of discussion will be: The utilization of fuel resources, the best utilization of water power, recent advances in irrigation methods, the elimination of waste including standardization of supplies for agricultural and industrial purposes, coal as a factor in industrial development, essentials of a national railroad policy, inter-continental engineering co-operation, port developments, terminal facilities, and the iron and steel industries.

Missed Shot Kills Two on Hetch Hetchy

A drill striking a missed shot in Priest Portal of the Hetch Hetchy tunnel on June 16 caused the explosion of a powder charge that killed the shift boss and a driller's helper and also slightly injured four other men.

HEADING OF BIG CREEK, ADIT 1, TUNNEL 3, ADVANCED 476 FT. IN MONTH

Chandler, Retiring Am. Soc. C. E. Acting Secretary, Honored

Tribute to the service of Elbert M. Chandler as acting secretary of the American Society of Civil Engineers during the past year was offered by a number of resident members of the society at an informal dinner held at the Harvard Club in New York on the evening of July 5.

J. Vipond Davies, president of the New York Section of the society, presided. Other speakers were Otis E. Hovey, treasurer, Am. Soc. C. E. and Robert Ridgway, vice-president Am. Soc. C. E. and senior past-president of the New York Section. Letters of appreciation and good-will were read from Clemens Herschel, past-president, Am. Soc. C. E. and Prof. John H. Dunlap, the newly-elected secretary of the society.

Resolutions expressing the personal regard of those present for Mr. Chandler and their respect for his work as acting secretary were approved and will be engrossed and presented to him. In response, he emphasized the importance of harmony in the society and urged full support of the new secretary.

Congressional Committee Urges Transportation Institute

Establishment of a private research and educational institution under disinterested auspices to promote education in transportation will be recommended by the Joint Commission of Agricultural Inquiry in its report on transportation.

The chairman of the commission points out that there are approximately $50,000,000,000 invested in transportation in this country, including steam railways, electric railways, highways, automobiles, motor trucks, waterways, and shipping, while there is no way to learn the business of transportation except by apprenticeship in the business itself. The purpose of the proposed institution would be to provide a means for definitely establishing the facts and principles of transportation upon which can be predicated sound decisions respecting transportation policies, and for setting forth the relation between the various agencies of transportation and their relation to agriculture, industry, trade, and commerce.

Port Authorities Will Meet in Toronto

The eleventh annual convention of the American Association of Port Authorities is to be held in Toronto, Ont., Sept. 14 to 16, 1922. The convention will be followed by an excursion down the St. Lawrence River to Montreal and then to Quebec, at both of which cities the port facilities will be inspected under the auspices of the local authorities. The secretary of the association is M. P. Fennell, Jr., of the Port of Montreal.

Appoint Board of Engineers for Moffat Tunnel

In connection with the construction of the Moffat Tunnel, as recorded in *Engineering News-Record*, May 18, pp. 811 and 836 and July 6, p. 38, the tunnel commission in charge of the work has appointed a board of consulting engineers consisting of J. Vipond Davies and J. Waldo Smith of New York, and D. W. Brunton of Denver. The board convenes at Denver this week for consideration of the project, which is under the direction of L. D. Blauvelt, chief engineer for the commission.

Southern Ry. Adopts 100-Lb. Rail for Main Line Tracks

One hundred pound rail has been adopted by the Southern Railway System as the standard for its main lines in place of 85-pound rail, the heaviest used on the Southern up to this time according to an announcement by H. W. Miller, vice-president in charge of operation.

The first stretch to be laid with the heavier steel will extend from Washington to Manassas, Va., a distance of 33 miles. The rail and fastenings are already on the ground and will be put in the track as soon as the heavy traffic movement of the peach and watermelon season is over. The new rail will be laid on extra heavy tie plates.

The 85-pound rail released by the laying of 100-pound rail on the main lines will be used to replace lighter rail on branch lines.

Will Not Raise Reversible Falls Steel Cantilever Bridge

St. John lumber shipping interests have failed in an attempt to compel the Canadian Pacific Ry. to raise the new steel cantilever bridge spanning Reversible Falls at the mouth of St. John River. They demanded that the company be required to raise the bridge 7 ft., contending that large schooners were unable to pass under the structure at flow tide, which is the only time at which craft can be towed through from St. John harbor to Indiantown harbor or vice versa. It was claimed that schooners have broken top masts in passing under the bridge.

At a meeting attended by representatives of the shipping interests, of the railway, of the city of St. John, and of the provincial and federal governments the arguments for raising the bridge were set forth. Canadian Pacific engineers contended that raising the bridge would weaken it and produce a dangerous condition.

There are now three bridges at the falls, two belonging to the Canadian Pacific Ry. and a highway bridge. The latter, replacing the old suspension bridge built in 1870, is a steel arch bridge completed five or six years ago. The first contilever bridge of the Canadian Pacific, built in 1871, and the the new cantilever bridge, completed last year, are side by side. The new bridge is farthest down the river, and the agitation was directed against this structure, although it gives 2½ ft. more headroom for navigation than does the old cantilever bridge which is directly alongside.

The Engineer in Public Life

JAMES HARTNESS

At the election held Nov. 2, 1920, the State of Vermont chose an engineer, James Hartness, president of the Jones & Lamson Machine Company, of Springfield, as governor. His previous experience in public life included six years as chairman of the Vermont State Board of Education. Mr. Hartness was born Sept. 3, 1861, in Schenectady, N. Y., and at the age of sixteen began work in a machine shop at five cents an hour for a nine-hour day. Here he developed such skill that when twenty-one years old he was made foreman of a nut and bolt shop at Winsted, Conn. After various connections in New England he took charge of the Jones & Lamson Machine Co.'s plant at Springfield, Vt. The firm today employs 3,000 men compared with 75 when Mr. Hartness joined it, and produces $10,000,000 worth of machine tools per year, as against $30,000 worth of tools in the old days.

Mr. Hartness has taken out more than 100 patents relating principally to machine tool design. In 1913 he was elected president of the American Society of Mechanical Engineers, succeeding George Westinghouse. During the war his plant at Springfield made parts for 9-in. howitzers. He served as federal food administrator for Vermont and was chairman of the Vermont Committee of Public Safety and a member of the commission representing the United States Air Board at the Inter-Allied Aircraft Standardization Conference at London and Paris.

During his administration Governor Hartness has reorganized the state highway department, created a state commission on foreign and domestic commerce, and initiated a number of measures to further the state's industrial progress.

Ransdell Bill Proposes Federal Hydraulic Laboratory

A national hydraulic laboratory is proposed in bills introduced simultaneously in the Senate and in the House of Representatives on June 13. The bill sets forth that the laboratory is to conduct research, experiments and scientific studies in connection with the problems of river hydraulics. An appropriation of $200,000 is authorized for the purpose. The author of the bill is Senator Ransdell, of Louisiana, and the Federated American Engineering Societies had a good deal to do with the initiation of the legislation. The federation expects to conduct some educational work with the idea of pointing out the necessity for approaching flood control and other matters involved in river hydraulics from a scientific angle.

Horace E. Stevens

Horace E. Stevens, late vice-president of Winston Bros. Co., contractors, Minneapolis, whose death was noted in the columns of this journal recently, was one of those technical men whose early experiences in engineering were largely colored by the romance of transcontinental railroad building, although his activities embraced practically all of the various branches of civil engineering.

Mr. Stevens was one of the first two men to receive the degree of civil engineer from the University of Vermont, from which institution he was graduated with Henry H. Douglas in 1870. In the fall of the same year he went to St. Paul, Minn., securing a position in the engineering corps of the Northern Pacific R.R. Co., where he remained until October, 1873. In the meantime he was engaged in location and construction work of the lines of that railway between Carleton and Moorhead, Minn. In March, 1873 he was ordered with a party of six men and teams to drive with the greatest speed possible across country to the projected crossing of the Missouri River, to stake out claims and secure squatter's rights for the benefit of the railroad company before the arrival of a party of land speculators already on the way. The race was a hard one, through snow and blizzards for seven days. First one party forged ahead, and then the other, both arriving at the site of the proposed crossing in the early morning of April 1. Some of the engineers, however, were able to drive the claim stakes while the others, with their rifles, held the land speculators back. These stakes marked the beginning of Bismarck, the capital city of North Dakota.

In June of that year Mr. Stevens was transferred to an expedition detailed to make a survey west of the Missouri River. A party of government engineers accompanied the railroad locating outfit, as well as did a detachment of government troops under General Stanley, consisting of about 900 infantrymen and 800 of the 7th Cavalry, 100 Indian scouts and a supply train.

Government Work

From 1873 to 1881 Mr. Stevens was employed by the government in river and harbor work. He was engaged mainly in the Mississippi River basin in survey work. In 1882-83 he was identified with Robinson & Cary, dealers in machinery and contractors' supplies, in St. Paul. For the next two years he did his first contract work, which was a section of the aqueduct for the St. Paul water-works, and some government harbor work on the Mississippi at Stockholm, Wis. In 1886 he became superintendent for Shepard, Siems & Co. on the construction of the Great Northern Ry. For the next two years he was superintendent of construction of the Soo Line near Escanaba, Mich., for Henry & Balch, and from 1889-93 he was engaged in miscellaneous contracting work in Duluth and St. Paul, Minn., Superior, Wis., and Brainerd, Minn.

Early in 1898 he was selected as one of a committee of engineers and contractors to go over the proposed Nicaragua Canal route for the purpose of investigating and determining the possibilities of the project.

Later in 1898 he became associated with Winston Bros., Minneapolis, and from then on he was engaged on various railroad jobs for that company. When Winston Bros. incorporated in 1902 as Winston Bros. Co. Mr. Stevens became a stockholder and director, and from 1914 to 1920 he was vice-president of the corporation.

Mr. Stevens was a member of the American Society of Civil Engineers, the Chicago Engineers Club, the Engineers Society of St. Paul, and during 1919 was president of the Minnesota Joint Engineering Board.

Canadian Section, A. W. W. A., to Meet at Windsor in 1923

At the recent annual meeting of the Canadian Section of the American Water Works Association at Brantford, Ont., it was decided to hold the next annual convention of the section at Windsor, Ont., just across the line from Detroit, Mich., where the parent association will convene in 1923. Officers for 1922-3 elected by the Canadian Association are: Chairman, R. L. Dobbin, Peterboro, Ont.; vice-chairman, F. A. Dallyn, Toronto; secretary-treasurer, C. B. Brown, Waterville, Ont.

Oppose Incorporation of American Mathematical Society

Objections by Representatives Stafford, of Wisconsin, and Huddleston, of Alabama, recently prevented passage by the House of a bill to incorporate the American Mathematical Society. Representative Stafford said if Congress intended to incorporate every scientific society it should do so by a general law and not in special bills for each society, referring to the possibility that the American Automotive Society and the American Chemical Society might desire incorporation. Representative Huddleston opposed incorporation of societies by Congress on general principles.

Vehicle Tunnel Under Hackensack May Replace Wrecked Bridge

Substitution of a tunnel crossing under the Hackensack River for the wrecked bridge of the Lincoln Highway, between Jersey City and Newark, N. J., is being considered by the state highway commission. The draw-span of the bridge was destroyed June 22 by a colliding steamer, as reported in this journal, June 29, p. 1095. Contract has been let by the commission for a temporary bridge, the contractors being the Stillman, Delehanty & Ferris Co., Jersey City. The temporary crossing is to have a 40-ft. roadway, will be located just upstream of the old bridge but clear of the wreckage of the draw, and will contain a bascule or lift span in place of one of the channels of the old draw. The state took over the road from the counties July 1. Provision of a permanent crossing is likely to be delayed for some time.

The traffic capacity of the old bridge was not considered adequate for the heavy traffic which the Lincoln Highway now carries and the channel widths in the draw have not been considered satisfactory for navigation. A tunnel crossing is being considered as an alternative solution, to eliminate all interference between road and river traffic.

Government Completes Sale of Spruce Corporation Property

The Secretary of War announces the sale, as of June 26, of the remaining real properties of the U. S. Spruce Production Corp., consisting of Spruce Production Corporation Railroad (36 miles), running from Disque Junction to Lake Pleasant, Clallam County, Wash.; the Port Angeles saw mill and hotel owned by the corporation in Port Angeles, Wash.

The properties sold for $1,000,000 and the contract of sale contains many features advantageous to the government, such as the immediate elimination of operating and maintenance charges, and obligation on the part of the purchaser to make at least $200,000 worth of improvements in the properties within one year.

The purchasers of these properties Messrs. Hill, Scritsmier and Lyon, had previously purchased the Alsea Southern R. R., the Toledo saw mill, and the Blodgett timber tract, and have placed those properties on a basis where logging and lumbering operations can commence about the middle of July. The purchasers guarantee to operate the railroad as a common carrier.

The Secretary of War also announces that the sale of these properties removes the last obstacle to the commencement of dissolution proceedings by the U. S. Spruce Production Corp., in accordance with the provisions of the law which created it. Steps will be taken to file a petition for dissolution before the Superior Court of Clarke County, Wash., before July 2, 1922.

Baltimore Terminal Suffers $4,000,000 Fire Damage

Struck by lightning on the night of July 2, elevators B and C and pier 5 at the Locust Point terminal of the Baltimore & Ohio R.R., in Baltimore, were destroyed by fire. The elevators contained more than 500,000 bu. of grain, which was destroyed along with sixty carloads of export tobacco that was on the pier. The estimated loss to the railroad company is $4,000,000.

Purdue Acquires Land for Engineering School

Henry W. Marshall, acting president of Purdue University, has announced the purchase of a tract of land two blocks long and a half block wide from seven different owners to provide additional building space in anticipation of the future growth of the university's engineering school. The land borders the athletic field.

Civil Service Examinations

UNITED STATES

For the United States civil service examinations listed below apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the Civil Service Commission.

Vacancies in Signal Service at large, Camp Alfred Vail, N. J. Junior Radio Engineer, $1,700 per year. Examination Aug. 9.

Vacancies in the Technical Staff of the Income Tax Unit of the Bureau of Internal Revenue. Valuation Engineer, $3,600-$4,800 per year. Applications close Sept. 1.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston; Annual Convention, New Bedford, Mass., Sept. 12-15.

AMERICAN ASSOCIATION OF PORT AUTHORITIES; Montreal, Que.; Annual Convention, Toronto, Ont., Sept. 14-16.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Petersburg, Fla.; Annual Convention, Cleveland, Ohio, Oct. 2-6.

The Seattle chapter, Associated General Contractors of America, has elected H. V. Bogert, Seattle, executive secretary. Mr. Bogert was formerly business manager of the Central Sand & Gravel Co.

The Seattle chapter, American Association of Engineers, recently sponsored a public meeting at which Fred A. Adams, supervisor and educational director of the Columbia Basin project, and Ivan E. Goodner, chief engineer, explained the huge irrigation plans. Stereopticon slides illustrated the talks.

The National Safety Council will hold its annual Safety Congress at Detroit on Aug. 28-Sept. 1. There are numerous papers to be presented at the sessions of the Engineering Section of the Congress. The chairman of the Engineering Section is H. W. Forster, vice-chairman of the Independence Bureau, Phialdelphia, Pa.

The Engineers' Society of Milwaukee at its meeting on June 21 elected the following officers: President, Arthur Simon, engineer of the Cutler-Hammer Manufacturing Co.; vice-president, Fred H. Dorner, mechanical engineer; treasurer, A. Q. Dufour, mechanical engineer, and secretary, Fred T. Goes, engineer of the Vilter Manufacturing Co. At the conclusion of the meeting Mr. Dorner was presented with a gold watch in appreciation of his services as secretary of the society for the past ten years.

Personal Notes

SALVADOR QUINONES, who has been practising engineering in Rio Piedras, Porto Rico, has opened an office in Mayaguez, Porto Rico.

CHARLES W. BOCKELMAN announces the opening of a surveying office in Newark, N. J.

GEN. GEORGE W. GOETHALS has been elected a director of the American Smelting & Refining Co., and the American Smelters Securities Co.

C. F. KOPPISCH, engineer with the Lee J. Smith Construction Co., Charlotte, N. C., has resigned to accept a position as superintendent of the Harris Construction Co., whose home office is in Newton, N. C.

ST. GEORGE BOSWELL, chief engineer of the Quebec Harbor Commission, has resigned after forty-six years' service with the commission. He will be retained on the engineering staff as a consultant. He is succeeded as chief engineer by GEN. T. L. TREMBLAY.

CHARLES A. PATTERSON, borough engineer of Torrington, Conn., has recently resigned and has accepted a position as chief engineer of the contracting firm of Mascetti & Holley of Torrington.

CLAYTON E. SWAIN, superintendent of public works, Rockville, Conn., has resigned, effective July 29. Thereafter he will be associated with the U. S. Bureau of Public Roads.

ROBERT E. KELLEY, of Willimantic, Conn., graduate of the 1922 class of the University of Maine, has been appointed an engineer of bridge construction for the Maine State Highway Department.

ARTHUR PARENT, superintendent of the city lighting department and deputy director of public work of the City of Montreal, Que., has entered upon his thirty-third year in the service of the city.

WALTER J. KING has been appointed Kansas representative of the Portland Cement Association to succeed FRANK ALTMAN. Mr. King is an engineering graduate of Kansas State Agricultural College and has been county engineer of Labette County, Kan., for five years.

EDWIN J. STEPHENSON, until recently employed as contruction engineer by the United Light and Railway Cos., Davenport, Iowa, has been appointed chief engineer of public construction for the city of Davenport.

JOHN C. BRIGHAM has been reappointed city engineer of Summit, N. J., for a term of three years.

Obituary

JOHN E. SHOEMAKER, for a number of years connected with the contracting firm of Swensson & Co., Seattle, Wash., and former assistant engineer of the Port of Seattle, was killed in the recent Lester mine trouble near Herrin, Ill., when striking miners and strike breakers engaged in a pitched battle. At the time of his death Mr. Shoemaker was chief engineer of the Southern Illinois Coal Co.

FRANK E. CHESLEY, whose engineering practice included municipal and government work in Iowa, Illinois, Virginia, Pennsylvania, and North Carolina, died recently at Goldsboro, N. C., aged 43 years. His early professional experience included engineering supervision in connection with sanitary sewer construction in various Pennsylvania towns. He was a graduate of the State University of Iowa, a member of the Engineering Society of Pittsburgh, where he was located for seven years, and an associate member of the American Society of Civil Engineers. Mr. Chesley early became interested in licensing laws for engineers and was active in the passage of the Iowa and North Carolina laws.

HENRY S. HAINES, surveyor-general of New Jersey for 40 years, died at his home in Burlington, N. J., June 25, aged 87 years. He was formerly engineer of the City of Burlington and other New Jersey municipalities.

Business Notes

THE SPEARS-WELLS MACHINERY CO., Oakland, Cal., has been appointed an agency for the handling in Northern California of the sales of concrete mixers, pavers, and excavators and loaders made by the T. L. Smith Co. of Milwaukee.

CHARLES M. SCHWAB has been elected chairman of the board of directors of the Chicago Pneumatic Tool Co. At the annual meeting of the board of directors held in March the chairmanship was left open pending the return of JOHN R. MCGINLEY in the hope that he would reconsider his earlier expressed wish to retire from certain business activities. The election of Mr. Schwab was at the instance of Mr. McGinley.

THE WILSON WELDER & METALS CO., New York City, has appointed the King-Knight Co., San Francisco, exclusive representatives in central and northern California for the company's products.

THE WESTINGHOUSE ELECTRIC CO., East Pittsburgh, Pa., announces changes in its power sales department including the promotion of three managers and the creation of two new managerships. L. C. BULLINGTON, assistant to the manager of the power department for several years, has been made assistant manager. CHARLES F. LLOYD, former manager of the substation section, has been made manager of the electric division, and R. E. CAROTHERS, formerly manager of the turbine section, has been appointed manager of the steam division. Vacancies caused by the promotions of Mr. Lloyd and Mr. Carothers have been filled by elevating BRUCE H. LYTLE and D. O. TYLEE, the former becoming manager of the substation section and the latter, manager of the turbine section.

THE ECONOMY FUSE and MANUFACTURING CO., Chicago, announces appointment of CHARLES H. BLUSKE as district sales manager of the Los Angeles office. Mr. Bluske was formerly connected with the Pacific States Electric Co. of Los Angeles and succeeds GEORGE L. DAVIS.

DWIGHT P. ROBINSON & CO., engineers and constructors with main offices in New York City, have entered into a contract with the Metropolitan Life Insurance Co. by which policies are provided without expense for all members of the contracting organization reporting to the central office. Policies are provided under a group insurance plan without cost to the employees.

Road Builders Executive Committee Meets

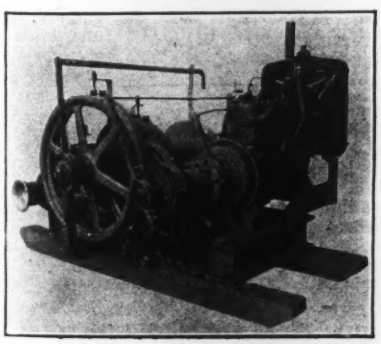
At a meeting in New York, July 7, the executive committee of the American Road Builders Association decided to place the management of the Good Roads Show to be held in the Coliseum, Chicago, during the week of Jan. 14, 1923, in the hands of E. L. Powers, the association's secretary, provided the choice of Mr. Powers is satisfactory to the Highway Industries Exhibitors Association. The executive committee will meet with a committee of the exhibitors at an early date to discuss plans for next year's convention and show.

The executive committee also took steps to have the association's books audited, to secure an office in New York separate from that devoted to Mr. Powers' private publishing activities, to have a new constitution for the society prepared, and to initiate a campaign of increasing the organization's membership. The entire membership of the committee was present and consisted of Thomas J. Wasser, J. H. Cranford, C. M. Upham, James H. MacDonald and E. L. Powers.

EQUIPMENT AND MATERIALS

Contractors' Gasoline Hoist for Double Elevator Work

To the contractors' hoist and derrick line built by the Pawling & Harnischfeger Co., of Milwaukee, has been added a gasoline-operated elevator hoist for double elevator work. The standard contractors' hoist may now be obtained equipped with an elevator sheave in place of the nigger-head on the back drum. Reversing is accomplished by means of friction clutches. An endless rope passes around the elevator sheave, then over guide sheaves and elevator head sheaves to the up and down elevators. The elevator sheave operates through a jaw clutch and works independent of the main drums.

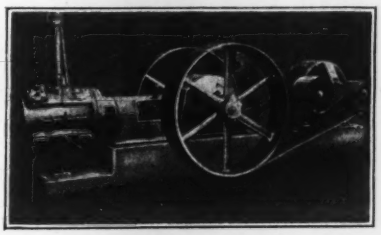


The main drums can be used for other purposes at any time.

The hoist shown in the illustration is the two-drum type equipped with a 5 x 6¼-in. Waukesha motor. The single line pull of this unit is 5,000 lb.; hoist speed, 185 ft. per minute; elevator sheave speed 500 to 550 ft. per minute with a rated load of 1,000 lb.

Air Compressor for Small Installations

The Norwalk Iron Works, South Norwalk, Conn., has placed on the market a single-stage air compressor designed



especially to meet requirements of small shops where air under pressure is needed to operate hoists, drills, hammers and similar tools.

The machine, compact in design, is of the center-crank, double-action type with a belt and flywheel on opposite ends of the crankshaft. The cylinder overhangs, and all valves are therefore readily accessible. The cylinder and heads are water jacketed. The valves are of the multiple-port plate type, designed to operate at high speeds. The working parts are entirely enclosed in an oil tight casing and are lubricated by the splash system. The end of the main frame to which the cylinder is bolted is provided with open ports at both sides so that the stuffing box is accessible for adjustment and repacking.

The machine is built in ten sizes, ranging in capacity from 57.6 cu.ft. of free air per minute up to 748 cu.ft. per minute. The cylinder diameter of the smallest size is 6 in., with 6 in. stroke. The largest size has a cylinder diameter of 18 in., with 12 in. stroke.

Larger Motor in Excavator and Loader

The Wisconsin four-cylinder gasoline engine used on its pavers has lead to the adoption of this make of motor on the excavators and loaders made by The T. L. Smith Co., of Wilwaukee. The new motor has 3-in. bore and 5-in. stroke and runs at 1,200 r.p.m. It pro-

vides about 40 per cent additional power over the previous equipment. The excavators and loaders are designed for general drag-line work, for digging basements and loading directly into wagons or trucks on the surface, for grading, stripping, and miscellaneous earth-handling and loading.

Out-of-the-Ordinary Trade Publications

The latest bulletin (No. 369) of the JEFFREY MANUFACTURING CO., Columbus, Ohio, illustrates and describes a new belt conveyor designed for loading and unloading coal, cinders, sand, gravel, crushed stone and similar material. It may also be used for brick, tile, small boxes and bags. The apparatus may be operated either by electric motor or gasoline engine and the capacity varies from 20 to 50 tons per hour. It is built in three sizes, 18, 24 and 30 ft. long. Two or more of the conveyors may be used in tandem to extend storage piles.

Developments of modern American locomotives for railway and industrial service in this country and abroad are the main subjects of the first number of a new monthly house organ of the BALDWIN LOCOMOTIVE WORKS, issued under the name of *Baldwin Locomotives*. Besides descriptions of several recent locomotives of different types there are articles on "The First Uniform Gage Transcontinental Railway in South America," "Logging Locomotives" and "South American Business." There are also two articles in Spanish on "The Patagonia Railways" and "New Locomotives for the Argentine State Railways." The transcontinental railway mentioned will be a meter-gage line between Buenos Ayres and Antofagasta, the last link of which is being built.

Requirements for a tar-macadam road, including design and construction details, are described in a 48-page booklet issued by the AMERICAN TAR PRODUCTS CO., Chicago. The text deals with both the hot mix and the penetration methods and a number of excellent photographs are shown of Tar-mac construction. An advantage claimed for this type of road is that a wider range of choice in the quality of stone is possible than in the case of a waterbound macadam road. A number of pages of the book are devoted to maintenance and repair problems, with specific instructions as to best methods for patching holes and mending surface breaks.

A new railroad equipment catalog has been issued by the WHITING CORP., Harvey, Ill. It is a 48-page booklet, profusely illustrated, and is designed to present to railroad men the advantages and labor-saving features of the company's various specialties, including locomotive hoists, cranes, transport tables, turntable tractors, and car wheel foundries.

Details of its Type 00 gasoline shovel are presented in an 8-p. pamphlet just issued by the THEW SHOVEL CO., Lorain, Ohio. A table is presented showing the working range of the shovel with 14-ft. and with 12-ft. dipper stick, together with text and pictures devoted to such details as the dipper, boom hinges, truck frame, etc.

"The Modern Chimney" is the title of an 18-page illustrated booklet which the WIEDERHOLT CONSTRUCTION CO., St. Louis, has published describing the use of its patented concrete-tile construction for chimneys, cooling towers, storage bins, and similar structures. The Wiederholt chimney is a continuous one-piece inside wall of reinforced concrete entirely inclosed by indestructible hard-burned tile of special shape forming a mold for the concrete. Tables are given showing the proper diameters and heights of chimneys for a wide range of horsepower.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Price Trend Since 1810 And What The Future May Hold

I. F. McDonnell Believes Future Trend Will Lie Between 1914 Trend and the Declines Following Other Wars

I. F. McDonnell, consulting engineer of the Alabama Public Service Commission, has given *Engineering News-Record* his opinion of future prices, based upon history.

"It is interesting in connection with the study of price fluctuations and their relation to business to compare the present after-war period with the same period after other wars. The chart shows prices during three wars from 1810 to 1922. It is interesting to note the similarity in the war peaks and perhaps it is significant that these war peaks have occurred at exactly fifty-year intervals. Studying the two previous after-war periods, it will be noticed that the previous war peaks have been followed by a thirty-year period of irregularly falling prices and a twenty-year period of rising prices.

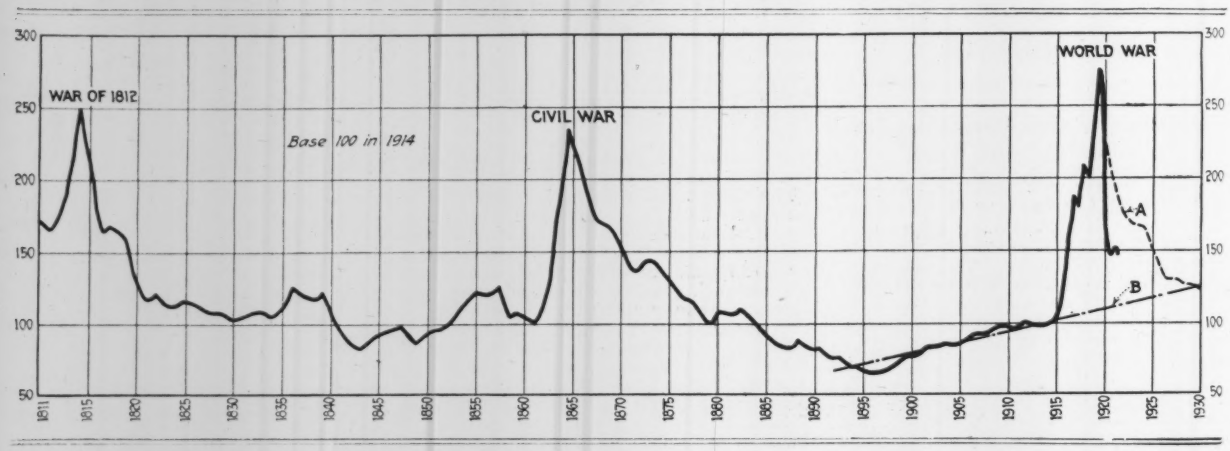
"To compare the two previous after-war periods with the present time, a composite curve 'A' of the two previous after-war price declines has been plotted in broken lines after the world war peak. From this it can be seen that the decline in prices after the world war has been accomplished far faster than ever before and we have reached the present level of 150 four years sooner than after the two previous wars. The causes of this are numerous and there is considerable difference among students of economics as to what have been the primary causes.

"Notice also the significant increase in prices from 1900 to 1914. Would this increase have continued had there been no war? An answer to this question would necessarily be based on so many assumptions as to be practically little better than a guess. However, to show the effect of this normal increase the line 'B' has been projected to 1930, where it intersects the broken line 'A' showing prices during the two previous after-war periods.

"The present price level of 150 is fairly stable, and a study of the present economic conditions leads to the belief that the future price course from today's level will be irregularly downward with even occasional increases over short periods.

"It is my opinion after careful consideration of all available facts, keeping in mind present economic conditions and their effect upon the preceeding after-war price trends, that it may be safely assumed that the future price trend will as a whole remain in the area formed by the converging lines 'A' and 'B'.

"It must be remembered that these are abnormal conditions and the assumptions leading to the above conclusions are based on the hope that the world will recover from its recent great illness without being stricken with further complications."



Business Briefs

Time loan rates unchanged over week; 4 per cent for 60@90 days, 4⅛ per cent for 4@6 months. Call money at 4@5 per cent as compared with 4@5½ per cent, week ending July 1.

German marks touch new low, 0.19c., July 8, as against 0.25⅝c. July 1, and 1.31c. one year ago. Sterling at $4.44¼; $4.42¼, last week; $3.66, one year ago. Francs at 7.81c.; 8.39½c., week previous and 7.82½c., year ago.

$2,500,000 in British gold received during week. First gold shipment to United States in over a year. Similar shipment now on way for like amount.

Automobile output nearly 250,000 cars in June as compared with 256,000 for May.

Petroleum output increases 12,000 bbl. in week ending July 1. Average daily production, 1,454,000 bbl. as against 1,441,350 bbl. during preceding week and 1,315,950 bbl. during corresponding week of last year.

Steel rails purchased by single railroad, amounted to 33,000 tons during 1921.

Freight Loadings Touch New High Mark

Revenue freight loadings totaled 877,856 cars for the week ending June 24, according to the American Railway Association, an increase of 17,084 cars over the week ending June 17, which held the record for car loadings up to that time. Ore and coal shipments made up the bulk of the gain with 64,284 ore cars loaded as against 53,822 for the previous week and 96,960 coal cars loaded as compared with 92,136 for the week preceding. Coke loadings totaled 9,466 cars, a gain of 164 over the previous week. Forest products totaled 64,271 cars, a gain of 189 over the week ending June 17.

SURPLUS AND SHORTAGE STATEMENT—JUNE 15TH TO 23, 1922

Districts	Flat Cars Surplus	Flat Cars Shortage	All Box Cars Surplus	All Box Cars Shortage	All Coal Cars Surplus	All Coal Cars Shortage	Total all Cars Surplus	Total all Cars Shortage
Eastern	544	.....	8,428	.....	63,880	.....	77,198	.....
Allegheny	79	.....	6,475	.....	66,492	.....	75,599	.....
Pocahontas	119	.....	312	.....	.....	1,522	681	1,522
Southern	1,704	34	5,927	858	2,629	690	12,841	1,611
North Western	1,091	.....	15,148	87	2,839	25	22,512	122
Central Western	237	98	19,794	102	22,624	.....	54,916	202
South Western	727	.....	6,493	31	2,269	.....	11,938	31
Total	4,501	132	62,577	1,078	160,733	2,237	255,685	3,488
Canadian Roads	440	.....	28,130	.....	1,015	.....	35,080	.....
Grand Total	4,941	132	90,727	1,078	161,748	2,237	290,765	3,488
June 15, 1922	5,805	155	91,250	1,019	172,722	511	306,983	1,696

Business Failures Fewer in Second Quarter

Returns for April and May had shown an appreciable decrease in number and liabilities of failures, and the June statistics reflect a continuance of the improving tendency. As against 7,517 defaults for $218,012,365 of indebtedness during the first quarter of this year, the second quarter's reports to R. G. Dun & Co. disclose 5,867 insolvencies for $155,703,973, exclusive of banking and other fiduciary suspensions. Thus, the statistics for the latest period reveal a decline of about 22 per cent. in number of failures and a contraction of more than 28 per cent. in amount of liabilities from those of the first three months of the present year, and the June defaults—1,740 in number—mark the smallest monthly total since last October. The June indebtedness of approximately $38,000,000 is, moreover, less than that of all months back to last September.

Following table shows geographic distribution of business failures:

Section	Number 1922	1921	1920	Liabilities 1922
New Eng.	530	409	167	$11,544,201
Middle Atl.	1,365	975	533	62,724,759
So. Atlantic	807	571	169	15,773,943
South Cent'l.	832	651	154	17,405,723
Cent'l East.	1,081	672	242	28,570,655
Cent'l West.	578	403	122	10,458,159
Western	180	163	73	3,657,012
Pacific	494	319	265	5,569,521
U. S.	5,867	4,163	1,725	$155,703,973
1921	4,163	.....	.....	130,273,615
Alaska	2	1	.....	$29,200
1921	1	.....	.....	5,000

Chicago Building Permits for June Double Those of Year Ago

Building permits issued at Chicago in June had a total value of $26,593,850 according to figures given out by Charles Bostrom, city building commissioner. This was only about $500,000 less than the high record for May. The June permits included 702 single family residences, 484 apartment buildings, 142 industrial structures and 84 miscellaneous types, a total of 1,412 as compared with 1,273 for May. Permits of June, 1921, totaled only 672 or less than half those for June 1, 1922.

Production and Materials Stocks in Nine Cities

Brick Output Nearest Normal in Two Years—No Shortage of Other Materials—Coal Situation Becoming Problem

Steel—Reports from thirty companies whose output was 87.5 per cent of the steel ingot production in 1921 produced 2,634,477 tons in June as against 2,711,141 tons for May and 1,003,406 tons during June, 1921. Despite this 3 per cent decline the tonnage for the first six months of this year was 13,499,386 compared with 9,006,855 tons for the first half of 1921. Unfilled steel tonnage for June, on the books of the United States Steel Corporation, totaled 5,635,531, a gain of 381,303 tons over the preceding month. Operations in the steel industry, generally, are proceeding at about 75 per cent of capacity. Sheets for automobile manufacture have shown marked demand during the last month. Sheet mills in the Youngstown district, during June, approached nearer 100 per cent capacity than at any time since the 1920 peak.

Lumber—An average of 345 mills reporting weekly to the National Lumber Manufacturers' Association for the four weeks ending July 1 show 831,815,725 ft. cut or a weekly average of 207,453,931 ft. b. m. as against 230,330,721 ft during the preceding four weeks. Latest figures show shipments 3 per cent, production 10 per cent and orders 15 per cent below normal.

Cement—May production according to United States Geological Survey totaled 11,176,000 bbl. which is an increase of 1,933,000 bbl. over April, 1922. Shipments increased 1,569,000 bbl., leaving stock amounting to 12,897,000 bbl. on June 1, 1922, a decrease of 1,573,000 bbl. from the preceding month.

Brick—A total of 93 firms reporting to the Common Brick Manufacturers' Association of America, as of June 1, show latest production figures at 89,000,000 with shipments reaching over 95,000,000. With shipments from the yards, during the month, greater than the number of brick produced; orders on the books for 258,000,000 and stocks on hand only 154,000,000, the coal situation becomes a real problem to the brick industry. Only one plant, however, is reported definitely closed for lack of coal.

San Francisco—Plenty of sewer pipe, cement, brick, asphalt and steel, but only fair supply of lime and hollow tile. Lumber moving rapidly and supplies of other building materials not mentioned above growing scarcer.

Denver—Brick shortage being slowly overcome. Small stocks but no serious delays in deliveries from yards. Large stocks of other materials at hand.

Minneapolis—Dealers' stocks of cement, lime, brick and hollow tile somewhat limited; loading direct from cars for delivery to jobs but no difficulty in obtaining supplies from mills on usual notice, 1@5 days. Retail lumber stocks heavier than a month ago; mills producing at normal rate. Brick supplies unusually low both in warehouses and at yards.

Detroit—Plenty of cement and common bricks; only moderate reserves of sewer pipe and hollow tile but small supply of asphalt. Lumber supply meeting demand and Michigan and Ohio mills shipping plenty of lime on short notice.

New Orleans—About 8 weeks' supply of lumber in reserve, 2 weeks' supply of cement but sufficient brick to meet building demands for one week only. All lumber mills, excepting few, disabled by high water, working full time, one mill in this district operating night and day.

Cincinnati—Heavy stocks of cement, brick and asphalt. Wood blocks also manufactured locally. One week required on shipments of granite blocks.

Atlanta—Sewer pipe deliveries take 24 hr.; hollow tile, 4 days. Plenty of brick, lumber and asphalt, 30@40 cars of cement, 40@50 cars of lime and 4@5 cars of structural steel.

Philadelphia—Sewer pipe shortage, due to coal strike, somewhat improved since last month. Active demands but sufficient supplies in asphalt, paving

CONDITIONS OF MATERIALS STOCKS IN IMPORTANT CENTERS

Stocks on hand in approximate figures, example: (cement, Denver, 10,000 bbl.); time required for delivery of carload lots to city job, example: (sewer pipe, Atlanta, 24 hr.); and stocks on hand in general terms, example: (common brick, New York, shortage.)

	Detroit	Minneapolis	Denver	Philadelphia	New Orleans	Atlanta	San Francisco	Cincinnati	New York
Sewer pipe	Moderate supply	.....	Del. 24 hr., local, plant.	Enough; demand easing up.	....	Del. 24 hr.	Local stocks large; near-by plants.	.....	Sufficient; del. prompt.
Cement	Plenty. Mills at capacity.	Del. direct from cars to job.	10,000 bbl.	Supply used as fast as del. from mill.	1,500 bbl. Using 750 bbl. per wk.	30 @ 40 cars	Heavy local stocks; quick mill del.	15,000 bbl.	Warehouses well stocked; mill del. prompt.
Lime, common and hydrated	10 @ 15 cars	Factory del. prompt.	Ample supply	Fair	.....	40 @ 50 cars	Fair	.....	Enough. Shortage prevented by scarcity of brick.
Common brick	Local yards furnish plenty	Stocks low	Small No delay in del. from yards	Stocks in yards used up.	500,000 or one week's supply	Plenty	Ample; yards well stocked	Several millions	Shortage.
Hollow tile	Moderate supply. Del. take several days.	Del. 24 hr. to 5 days.	Sufficient	.....	.....	Del. 4 days	Barely enough; shipments improving.	.....	Nearby plants at capacity.
Lumber	Normal. Stocks being replaced.	Retail stocks heavier.	Large stocks	Supply being used faster than replaced.	8,000,000 ft. Using 1,500,000 ft. weekly.	Plenty	20,000,000 ft.	.....	7 @ 8 wk. from mill.
Asphalt	Small supply.	.....	10 cars	Plentiful	.....	Sufficient	Well stocked at refineries	300 tons	Refineries near city.
Structural steel	.....	.....	.....	.....	.....	4 @ 5 cars.	Good supply of shapes plates and bars.	.....	Warehouse stocks heavy.

stone, lime and manila rope. Stocks in brick yards exhausted and cement demand using supply as fast as delivered to dealers. Sand gravel and crushed stone moving briskly with pits and quarries taxed to limit.

New York—Brick shortage continues; Hudson River plants working at maximum capacity; Hackensack, Raritan and other districts supplying New York have orders booked for twice as many brick as can be produced. No scarcity of lime but brick shortage alone has enabled lime supplies to hold out. Lumber mill shipments slower.

REPORT ON COMMON BRICK FROM 93 YARDS AS OF JUNE 1, 1922

Dist. No.	Including States of	No. of firms reporting	Plants closed down	Burned brick on hand	Unburned brick on hand	Orders on books	Price Per Thousand at brickyard
1.	N. Y., New England	8	3	4,690,000	3,609,000	4,210,000	$13.00 to $18.00
2.	Pa., N. J., Md., D. C., Del.	9	2	13,840,000	4,841,000	32,088,000	12.00 to 16.00
3.	Va., N. C., S. C., Ga., Fla.	5	1	2,466,000	1,346,000	3,850,000	11.00 to 16.00
4.	Mich., Ohio, W. Va.	7	0	2,762,000	1,642,000	11,474,000	11.00 to 13.00
5.	Ill., Ind., Wis.	26	1	100,535,000	1,898,000	184,053,000	10.50 to 20.00
6.	Ky., Tenn., Miss., Ala., Ark., La.	14	1	7,796,000	5,825,000	6,616,000	9.00 to 14.00
7.	N. and S. Dak., Minn., Neb., Ia., Kan., Mo.	10	3	5,523,000	2,625,000	2,770,000	10.00 to 14.50
8.	Okla., Tex., N. M.	6	1	3,507,000	1,885,000	1,511,000	8.00 to 12.00
9.	Wash., Ore., Mont., Wyo., Ida., Utah, Colo.	5	2	2,412,000	382,000	250,000	13.00 to 18.00
10.	Calif., Ariz., Nev.	3	0	2,205,000	7,838,000	11,681,000	14.00 to 15.00
		93	14	145,736,000	31,891,000	258,503,000	

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted. Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section. The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of July 6; the next, on August 3.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$2.68	$3.65	$4.00	+$2.68	$2.86	$3.60	$3.10	$3.60	$3.75
Structural rivets, 100 lb.	3.60	4.35	5.50	3.10	3.90	4.45	4.25	3.75	6.50
Reinforcing bars, ¾ in. up, 100 lb.	2.58	3.50	3.50	+2.58	2.76	3.67½	2.55	3.60	2.90
Steel pipe, black, 2½ to 6 in. lap, discount	61%	61.15%	45%	59½%	61.9-5%	—46%	49.1%	53%	30.00
Cast-iron pipe, 6 in. and over, ton	+50.80	+49.00	51.50	+46.60	50.50	57.00	51.00	53.00	50.00
Concreting Material:									
Cement without bags, bbl.	2.40@2.50	+2.50	2.25	—2.05	—2.29	2.90	2.63	2.90	—2.46
Gravel, ¾ in., cu.yd.	1.75	1.85	2.25	1.80	1.50	1.75	2.25	1.10	1.50
Sand, cu.yd.	1.00	1.15	2.25	1.80	1.00	0.75	1.50	1.10	1.25
Crushed stone, ¾ in., cu.yd.	1.75	1.90	2.73	1.60	2.25	3.50	2.25	3.00	2.00
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	49.00	39.00	+39.00	+49.00	+41.00	+51.00	+31.00	22.50	47.00
Lime, finishing, hydrated, ton	—15.80@16.17	+23.00	25.00	18.00	29.00	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	—2.75@3.14½	+1.80	2.50	1.40	1.40	2.70	1.75	2.80	11.00
Common brick, delivered, 1,000.	23.50@24.60	11.00	11.15	11.00	+17@18	12.00	15.00	14.00	16.00
Hollow building tile, 4x12x12, per block	Not used	.075	.115	.0707	+.086	.08	....	.12	.09
Hollow partition tile 4x12x12, per block	.1112	.0707	.115	.0657	....	.08	.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal.	+.93	+1.00	1.07	+.98	+1.03	+1.12	1.04	.86	—1.04
Common Labor:									
Common labor, union, hour	.75	.35	.....	.80	.....	.50@.55	.56¼	.50@.60	.....
Common labor, non-union, hour	.44@.60	.20	.25	.72½	.35@.50	.35@.50	.47½@.50	.....	.20@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed store quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.55 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir common.

Seattle quotes on Douglas fir instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at pit.

Montreal quotes on Douglas fir instead of pine. Sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 98.76 cents. Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½-in., $30; 6-in., $110.

Changes Since Last Week

Steel, wrought pipe, lumber, brick and linseed oil have all shown upward price tendencies during the last two weeks, despite recent freight reductions. Cement, however, has reflected the freight decrease. Chicago quotes cement at $2.05 as against $2.07; Minneapolis, $2.29, reduced from $2.34 and Montreal, $2.46 as compared with $2.48 per bbl. Atlanta, however, quotes $2.50 as against $2.34 per bbl. Demand for principal construction materals in Atlanta is at least 75 per cent greater than a year ago. Quotations of $1.60 on structural steel, f.o.b. Pittsburgh, receding somewhat; most transactions at $1.70@$1.80 per 100 lb. for deliveries in third quarter.

Pine lumber up $1 in Dallas and $4 in Chicago; Douglas fir advanced $1 in Minneapolis, $2 in Denver and $6 per M. ft. b.m. in San Francico. Heavy lumber demand continues with mills and logging camps, in the Northwest, running two shifts and still unable to keep apace of orders.

Continued activity in the paint trade has given raw linseed oil another upward turn. Atlanta quotes advance of 6c., New York 5c., Minneapolis and Denver 4c., and Chicago 2c. per gal., in 5 bbl. lots.

Brick up $1 per M in Minneapolis.